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UNIVERSITY OF ILLINOIS  
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BULLETIN No. 137

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A STUDY OF FACTORS INFLUENCING THE  
COMPOSITION OF BUTTER

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BY CARL E. LEE, NELSON W. HEPBURN AND JESSE M. BARNHART



URBANA, ILLINOIS, SEPTEMBER, 1909

## SUMMARY OF BULLETIN No. 137

1. There is a variation in the water content, ranging from 0.1 to 1.0 percent, between different samples representing the same butter. The average variation is about 0.5 of one percent.

2. There was no variation in water content between half worked and worked butter or after the third revolution of the churn until working was completed.

3. There was no difference in composition of samples taken from the middle or either end of the churn.

4. The percent of water in butter is affected by the make of churn.

5. There was no difference in composition of butter made from cream held 1 to 3 hours and that held 12 to 15 hours at churning temperature.

6. Butter of the same composition can be made from either pasteurized or unpasteurized cream.

7. Dry and wet salting methods are identical as far as composition is concerned.

8. Churning of butter washed with water, differing ten degrees in temperature, produced butter with an average difference in water content in 40 comparisons of 1.99 percent.

9. In churning 7241.16 pounds of butter fat in 56 different churnings; according to analyses of samples taken from 108 tubs, 7154.43 pounds of fat were recovered in the butter, giving a difference of 1.23 percent.

10. In another comparison covering a period of two months the butter fat delivered according to the testing of 1494 deliveries of milk and cream was 17,995.84 pounds; according to the test of the 40 different vats of cream before starter was added 17,863.83 pounds; according to test after starter was added 17,853.84 pounds of butter fat were churned in the 80 churnings. This made a total of 21,123 pounds of butter. According to analysis of one sample taken from each churning 17,668.6 pounds of butter fat were recovered. According to samples taken from four tubs packed from each churning 17,851.4 pounds of butter fat were recovered. Difference between butter fat churned according to test after starter was added and analyses of tub samples was 0.07 percent.

11. The approximate composition of a quantity of butter may be obtained by the analysis of a sample from any tub of that butter.

12. In terms of averages, samples taken from the butter in the churn will contain nearly one percent more moisture than samples taken from the butter in the tubs. The same decrease is true of samples taken from tubs of butter before and after storage.

13. Two lots of butter each represented by 40 churnings, two tubs of butter from each churning, with an average difference in water content of 1.99 percent were identical in quality.

14. It is possible to make butter from day to day of uniform and desired composition.



# A STUDY OF FACTORS INFLUENCING THE COMPOSITION OF BUTTER

BY CARL E. LEE, ASSISTANT CHIEF, DAIRY MANUFACTURES,  
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## INTRODUCTION

A study of the factors influencing the composition of butter is of importance, not alone on account of its relation to science, but also because of the practical application the knowledge derived from such a study, bears to the creamery industry.

The control of the composition of butter is of great value to the producer, manufacturer, and butter dealer. The dairymen who make and sell dairy butter are directly interested in quality and they should be interested in composition in so far as it might affect their net returns.

All milk producers who are share-holders, or dispose of their milk and cream to coöperative creameries, are interested in both quality and composition, because the price paid for butter fat by these concerns is largely regulated by these two factors. Owners of stock or individual creameries should be interested in the quality of butter yet the question of composition should not be overlooked since both play a large part in making a plant successful. As a rule the price these creameries pay the producer is regulated by market butter quotations and not the net returns for a given amount of butter fat made into butter. It is evident, therefore, that aside from quality a knowledge of the control of the fat content in the finished butter involves a financial problem. Naturally the percent of salt in butter must be regulated by the demand of the consumer, hence it is to the creamerymen's interest to comply with such demand even tho it may affect the total number of pounds of butter made.

A certain amount of water is necessary to make butter mechanically perfect. However, this does not mean that the percent of water must come within very narrow limits. The law sets the maximum amount at 16 percent. While it is true that two lots of butter varying 2 to 4 percent in water content can in a measure be distinguished when the body is comparatively uniform, the general appearance of a package or quantity of butter is not a sure indication of its composition. The dealer has a right to demand butter of such composition that it will safely be within the limits of the law and of such a texture that it will permit handling without a great deal of shrinkage.

Those who have made a study of manufacturing butter know that composition will vary with local, seasonal, and other conditions, unless these factors affecting butter fat are overcome.

In addition to studying some of the factors influencing the composition of butter, it seemed wise to collect samples from the market for analysis which would furnish data for comparisons between different markets, states, and factories. These samples were no doubt fairly representative of the butter received on the Aurora, Elgin, and Chicago markets, during the seasons of 1907 and 1908. Results of analyzing these samples of market butter are reported in another bulletin.

#### SAMPLING BUTTER

A study was made of the uniformity in composition of various samples taken from the same churning or package. It is apparent that in taking a sample of butter from the tub more or less water is forced to the top of the package, as the trier is inserted. This free brine, as a rule, is picked up by the surface of the plug and trier when it is removed. In transferring the butter from the trier to the sampling jar all the free water adhering to the butter is collected with the sample. It is difficult to say whether or not this method of sampling is to be relied upon. However, it is the only method that can be followed without defacing the package. After the trier of butter is drawn and the sample taken, the top two inches is replaced, thus leaving the surface of the package in the same condition as if it had been examined for quality only.

It is noted that the amount of brine forced to the surface varies with the condition of the butter. When the butter is in a very soft condition, little brine is forced out and at the same time less water is seen on the trier. Storage or frozen butter shows no visible water either on the top of the tub or on the trier plug. Butter commonly found in the commission house did show this free water. It seemed, therefore, reasonable to sample the butter in that condition and at the same time carry on investigational work to ascertain the accuracy of this method of sampling.

May 10, 1907, a churning of 242 pounds of butter was printed in a Lusted printer. Before any of the butter was taken from the churn, the surface was cut off, and a sample taken from various places in the churn, and mixed in one sampling jar. This sample contained 14.05 percent of water. From each tray of 25 pounds the center one pound print was removed and a portion of it placed in a sampling jar. It was found that the sample from tray 1 contained 13.25 percent of water and the analysis of the other nine samples gave the following results: Sample No. 2, 13.41; No. 3, 13.05; No. 4, 13.38; No. 5, 13.21; No. 6, 13.01; No. 7, 13.68; No. 8, 12.99; No. 9, 13.21; and sample No. 10, 13.25 percent. Average for the 10 samples taken from the one pound prints of butter was 13.24 or 0.31 of one percent less water than was found in the samples taken from the churn. The butter made three days later was sampled in the same manner. Samples taken from the churn contained 13.64 percent of water. The average

percent of water, of the seven samples taken from the butter after it was printed was 13.27. The highest water content, 13.96 percent, was in sample from tray No. 5 and lowest 12.71, from tray No. 4.

May 15 all of the cream received was churned in two different churnings. The method of making and sampling the butter was the same as in the two previous lots. The sample taken from the butter in the first churn contained 13.74 percent water. The average of samples from seven trays 13.39 percent; highest water content 13.84 from tray No. 3; lowest 12.83 percent from tray No. 4. The samples taken from churn 2 contained 13.39 percent of water. The average water content of the samples from the seven different trays was 13.37 percent; highest 13.57 from tray No. 5 and lowest 13.05 percent from tray No. 1, indicating clearly that there is a variation in the water content of samples of butter taken from the same churning.

A comparison was made to determine whether there was any greater variation in sampling the butter in the churn by means of a trier or a spatula. The following data were obtained from one day's churning. The butter in churn 1 was worked 20 revolutions of the churn. Four samples were taken, two with a spatula and two with a trier. Spatula samples contained 13.26 and 13.24 percent water, respectively, and trier samples, 13.66 and 14.28 percent. One-half of the butter was taken out and printed with a Lusted printer into 125 one-pound prints. From each tray of 25 pounds the two center prints were removed for analysis. From one of these prints a sample was taken by means of a trier, and from the other the sample was made by cutting off one inch of the butter from each end, and one-half an inch from each side. The remainder of the pound print was placed in the sample jar, the analysis of which gave the following results:

Tray No.	Percent water Trier sample	Percent water Print sample	Tray No.	Percent water Trier sample	Percent water Print sample
1	14.10	13.43	4	13.30	13.30
2	13.92	13.11	5	14.32	13.25
3	13.53	13.79	..	.....	.....
Average five samples		.....	..	13.83	13.37

The remainder of the butter in the churn was overworked ten revolutions. None of the water was allowed to drain out. The method of printing and sampling was the same as above.

Tray No.	Percent water Trier sample	Percent water Print sample	Tray No.	Percent water Trier sample	Percent water Print sample
1	13.48	13.50	4	13.40	13.44
2	13.37	13.45	5	13.29	13.55
3	13.16	13.31	..	.....	.....
Average five samples		.....	..	13.34	13.31

The average water content in the ten one-pound prints of normal worked butter was 13.60 and the overworked 13.38 percent. The average water content of the 20 samples analyzed was 13.49 percent; the highest 14.32 and the lowest 13.11 percent. The average water content in the ten samples taken directly from the churn was 13.64; the

highest 14.28 and the lowest 13.24 percent. The average of all samples taken from the churn was 13.50 percent.

The remainder of the cream delivered on that day was handled in the same manner except that no water was added to the butter, in the churn, after salting. The method of sampling was the same as in the above churning. The amount of water in the samples taken from the worked butter in the churn with the spatula was 12.70 and 13.14 percent, and with the trier 12.48 and 12.67 percent.

Tray No.	Samples of worked butter		Samples of overworked butter	
	Percent water Trier sample	Percent water Print sample	Percent water Trier sample	Percent water Print sample
1	13.09	12.36	12.88	12.88
2	12.62	12.93	12.94	12.92
3	12.87	13.89	13.03	12.82
4	12.99	12.78	13.07	13.16
5	12.81	13.16	13.52	12.77
Average	12.87	13.02	13.09	12.91

The average water content in the ten samples of worked butter was 12.93 and that of the overworked butter 13.02 percent. The highest percent of water in a single sample was 13.89 and the lowest 12.64. Butter was made the same on the following day. Four different samples were taken for analysis. Sample No. 1 from lower end of churn contained 13.38 percent water. Sample No. 2 was taken half way between middle and lower end with 13.30 percent. Sample No. 3 was taken between middle and gear end with 13.44 percent and sample No. 4 was taken from the butter in the gear end with 13.51 percent. The average water content of all samples was 13.39 percent. It will be noted from the above data that there is no more variation in water content due to methods of sampling than there is between several samples taken in the same manner from one churn.

The following day the cream was churned in two lots and four samples taken from different places in the churn.

Churn 1		Churn 2	
Sample No.	Percent water	Sample No.	Percent water
1	13.82	1	13.05
2	13.46	2	13.30
3	13.86	3	13.52
4	13.69	4	14.24
Average	13.66		13.53

The butter in churn 1 was packed in four sixty pound tubs. These tubs were placed in a refrigerator at a temperature of 35 degrees F., and 24 hours later a trier full of butter was taken from each tub for analysis.

The water content was as follows:

Samples from tub 1, 13.68; tub 2, 13.00; tub 3, 13.52 and tub 4, 13.07 percent.

Twenty days later these four tubs were taken out of the refrigerator and placed in the churn room. The following day when the samples were taken the condition of the butter was similar to that sampled

on the market. From each package five samples of butter were removed by means of a trier.

TABLE 1. WATER CONTENT, PERCENT. SAMPLES TAKEN FROM FOUR DIFFERENT TUBS OF THE SAME CHURNING.

Sample No.	Tub 1	Tub 2	Tub 3	Tub 4
1	13.66	13.24	13.71	12.54
2	13.59	12.47	13.46	12.65
3	13.46	13.07	13.27	13.08
4	13.37	13.15	13.52	12.88
5	13.67	12.76	12.99	12.86
Average	13.55	12.94	13.39	12.80

The average water content in the 20 samples taken from the four tubs was 13.17 percent; highest 13.71 and lowest 12.47 percent.

Several churnings were handled in a manner to give variation in the composition of the butter. Samples were then taken by means of a spatula from various portions of the churn and placed in separate sample jars.

The following is an example of two consecutive churnings showing variation in composition of samples of butter from the same churn.

TABLE 2. VARIATION IN NINE SAMPLES FROM SAME CHURN

Sample No.	Churn 1, High water				Churn 2, Low water			
	Percent				Percent			
	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
1	15.87	79.35	3.81	0.97	14.76	82.29	2.17	0.78
2	16.36	78.17	4.43	1.05	14.32	82.72	2.40	0.56
3	15.43	79.87	3.72	1.07	14.23	82.75	2.28	0.74
4	16.41	78.56	4.17	0.86	14.83	81.96	2.63	0.58
5	16.11	78.98	4.15	0.75	14.39	82.57	2.26	0.78
6	16.77	77.86	4.55	0.82	14.95	81.77	2.24	1.04
7	15.60	79.02	4.41	0.97	14.54	82.33	2.09	1.04
8	15.47	79.79	3.62	1.12	14.36	82.59	2.07	0.98
9	15.48	79.68	3.88	0.96	13.84	83.33	1.96	0.87
Average	15.94	79.00	4.08	0.95	14.47	82.48	2.23	0.82

A sample made by taking butter from various places in the churn is fairly representative of the butter in question and the analysis of such a sample is a fair approximation of its chemical content.

#### COMPOSITION OF HALF WORKED AND WORKED BUTTER

It has been the practice for some time to work the butter continuously to the extent of 12 revolutions in the Victor churn and 18 in the Disbrow. When the butter had been worked 6 revolutions in the Victor churn and 9 in the Disbrow it was considered half worked.

In twenty-three consecutive churnings when the butter was half

worked a sample was taken by means of a spatula from several places in the churn. A sample was also taken, in like manner, when the butter in the same churn was completely worked.

TABLE 3. WATER IN HALF WORKED AND WORKED BUTTER

Churn No.	Percent of water		Churn No.	Percent of water		Churn No.	Percent of water		
	Half worked butter	Worked butter		Half worked butter	Worked butter		Half worked butter	Worked butter	
1	15.14	15.27	9	13.22	13.40	17	13.38	14.05	
2	13.76	14.27	10	13.99	13.27	18	13.17	13.30	
3	14.51	13.24	11	13.51	13.76	19	13.41	13.64	
4	13.92	13.41	12	13.60	13.22	20	13.17	13.30	
5	13.41	13.73	13	14.19	13.64	21	14.48	13.74	
6	13.41	14.18	14	14.16	13.68	22	13.49	13.39	
7	13.17	13.60	15	13.66	13.79	23	14.38	13.53	
8	13.17	13.60	16	14.08	14.03				
Average.....								13.76	13.70

The variation was no greater than if the two samples had been taken from the worked butter.

## CHANGE IN COMPOSITION MADE BY EACH REVOLUTION IN WORKING

Five consecutive churnings were used in this experiment. The samples of butter in each case were taken as uniformly as possible. Sample No. 1 was taken when the butter had been worked to the extent of 3 revolutions of the churn and sample No. 10 when worked twelve revolutions.

TABLE 4. COMPOSITION OF SAMPLES TAKEN AFTER EACH REVOLUTION

Sample No.	Revolutions	Churn 1				Churn 5			
		Percent				Percent			
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
1	3	13.92	83.82	1.58	0.68	13.38	83.30	2.51	0.81
2	4	14.31	83.26	1.71	0.72	13.66	82.61	2.92	0.81
3	5	14.17	83.58	1.53	0.72	13.41	83.41	2.57	0.81
4	6	14.59	83.07	1.73	0.51	13.26	83.13	2.74	0.87
5	7	14.67	82.81	1.68	0.84	13.66	82.67	2.83	0.82
6	8	14.84	82.77	1.62	0.77	13.41	83.02	2.78	0.79
7	9	14.26	83.51	1.54	0.69	13.82	82.40	2.81	0.97
8	10	14.75	82.79	1.62	0.84	13.63	82.63	2.81	0.93
9	11	14.24	83.41	1.56	0.79	13.97	82.32	2.89	0.82
10	12	14.94	82.72	1.67	0.67	13.63	82.71	2.92	0.74
Ave.....		14.48	83.17	1.62	0.72	13.58	82.79	2.78	0.84
Granular.....		16.87	82.43	0.06	0.64	17.12	81.78	0.46	0.64
Highest.....						13.97	83.41	2.92	0.97
Lowest.....						13.26	82.32	2.51	0.74

## AVERAGE COMPOSITION OF THE SAMPLES OBTAINED FROM THE FIVE CHURNINGS

14.36	82.03	2.70	0.88
Average of the highest samples from each churning			
14.90	82.89	2.93	1.09
Average of the lowest samples from each churning			
13.74	81.46	2.44	0.70

In all of these five churnings the variation in composition of the samples taken from each revolution of churn showed no greater difference than if all had been taken from the finished butter.

TABLE 5. COMPOSITION OF SAMPLES TAKEN FROM UPPER, MIDDLE, AND LOWER END OF CHURN, PERCENT.

Date	Upper end			Middle			Lower end		
	Water	Fat	Salt	Water	Fat	Salt	Water	Fat	Salt
Nov. 27	14.45	81.20	2.87	14.89	80.59	3.66	14.92	81.12	3.10
	14.96	80.55	3.63	14.88	80.52	3.77	15.02	81.26	2.99
Average...	14.71	80.88	3.25	14.89	80.56	3.71	14.97	81.19	3.05
Nov. 29	13.35	82.92	2.89	13.07	83.50	2.85	13.86	82.47	2.93
	12.78	83.61	2.78	13.19	83.16	2.88	13.43	82.94	2.79
	13.24	82.95	2.92	12.75	83.81	2.73	12.77	83.64	2.69
Average...	13.12	83.16	2.86	13.00	83.49	2.82	13.28	83.02	2.80
Nov. 30	15.45	81.05	3.59	14.38	81.18	3.49	14.43	81.09	3.57
	15.02	80.37	3.84	14.03	81.73	3.39	14.76	80.28	3.93
	14.92	80.45	3.77	15.01	80.34	3.62	14.47	80.93	3.71
Average...	15.13	80.62	3.77	14.48	81.08	3.50	14.55	80.77	3.73
Dec. 2	15.48	79.17	4.32	13.56	80.89	4.66	14.84	79.19	5.09
	14.93	80.02	4.03	14.53	79.41	4.89	14.52	79.44	4.98
	15.38	79.02	4.40	14.21	79.87	4.89	15.26	78.34	5.06
Average...	15.26	79.40	4.25	14.10	80.06	4.81	14.87	78.99	5.04
Dec. 4	14.81	80.53	3.75	14.73	80.69	3.65	14.91	79.87	4.34
Dec. 9	13.55	84.57	1.39	13.34	84.48	1.30	13.96	83.93	1.34
	13.23	84.99	1.62	13.92	83.81	1.37	13.74	84.43	1.40
	13.51	84.30	1.39	14.09	83.57	1.45	13.92	83.88	1.34
Average...	13.43	84.63	1.47	13.78	83.95	1.37	13.54	84.08	1.36
Gen. Av ..	14.41	81.54	3.22	14.16	81.64	3.31	14.35	81.32	3.39

## ABNORMAL BUTTER

Date	Upper end	Middle	Lower end	Date	Upper end	Middle	Lower end
	Water	Water	Water		Water	Water	Water
Oct. 16	20.06	20.24	20.40	Nov. 19	23.71	22.33	22.83
	19.95	19.93	21.05		23.49	22.51	22.28
	20.27	19.96	20.67		23.51	22.72	22.88
Av. ....	20.09	20.04	20.71		23.57	22.52	23.00

From the foregoing table it is seen that there are no special places in the churn where the butter is found differing uniformly from the average churn composition.

## COMPOSITION OF BUTTER MADE IN TWO DIFFERENT CHURNS

The two churns used in this experiment were not of the same size but the amount of cream churned in each one was in proportion to the capacity. All the details in the operations of the two churns were as nearly alike as possible.

TABLE 6. VARIATION IN COMPOSITION OF BUTTER FROM TWO DIFFERENT CHURNS Comparison 1

Sample No.	Churn A				Churn B			
	Percent				Percent			
	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
1.....	12.83	84.55	1.77	0.85	15.85	80.82	2.68	0.85
2.....	13.17	84.15	1.85	0.83	14.82	82.10	2.36	0.72
3.....	14.10	83.15	2.06	0.69	14.82	82.00	2.33	0.85
4.....	13.13	84.15	1.87	0.85	15.67	81.01	2.59	0.73
5.....	12.85	84.57	1.82	0.76	13.62	83.58	1.97	0.83
6.....	13.74	83.54	1.89	0.83	14.65	82.25	2.19	0.91
7.....	13.40	84.02	1.88	0.70	14.55	82.30	2.20	0.95
8.....	13.39	84.02	1.56	1.03	14.88	81.99	2.54	0.67
9.....	13.69	83.60	1.98	0.73	14.61	82.13	2.22	1.04
10.....	13.08	84.18	1.85	0.89	14.77	82.17	2.21	0.85
Av. ....	13.34	83.99	1.85	0.81	14.82	82.00	2.33	0.84
Highest. .	14.10	84.57	2.06	1.03	15.85	83.58	2.68	1.04
Lowest . .	12.83	83.15	1.56	0.69	13.62	80.82	1.97	0.67



## Comparison 2

Sample No.	Churn A				Churn B			
	Percent				Percent			
	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
1.....	13.14	83.57	2.45	0.84	14.49	82.15	2.45	0.94
2.....	13.85	82.69	2.57	0.89	15.42	80.69	2.80	1.09
3.....	14.04	82.62	2.69	0.85	14.62	81.74	2.73	0.86
4.....	13.04	83.75	2.32	0.89	15.01	80.99	3.08	0.92
5.....	13.58	82.98	2.47	0.97	14.73	81.36	2.88	1.03
Av. ....	13.53	.....	2.50	0.85	14.85	81.38	2.79	0.97
Highest. .	14.04	.....	2.69	0.97	15.42	82.15	3.08	1.09
Lowest ...	13.04	.....	2.32	0.85	14.49	80.69	2.45	0.86

## AVERAGE FOR EACH OF THE FIVE COMPARISONS

Comparison	Churn A				Churn B			
	Percent				Percent			
	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
1.....	13.34	83.99	1.85	0.81	14.82	82.00	2.33	0.84
2.....	13.53	83.12	2.50	0.85	14.85	81.88	2.79	0.97
3.....	13.50	83.44	2.04	1.00	14.83	82.52	1.74	0.90
4.....	13.40	82.69	3.00	0.91	14.65	81.68	2.79	0.88
5.....	14.04	83.01	2.24	0.70	15.09	81.10	3.10	0.71
Av. ....	13.56	83.25	2.30	0.85	14.84	81.73	2.55	0.86

Only two comparisons are given entire, but the average for the other three are included in the final average.

## COMPOSITION OF BUTTER AS INFLUENCED BY TIME THE CREAM IS HELD AT CHURNING TEMPERATURE

During the months of May and June, 1907, a series of experiments were carried on, in which butter made from cream held one to three hours was compared with butter made from the same grade of cream held twelve to fifteen hours at churning temperature. Twenty-six vats of cream were used, making a total of fifty-two churnings. One tub of butter was packed from each of the first four churnings, while two tubs were packed from each of the other forty-eight. Samples of butter were taken for analysis from the churn and from the tub before and after storage.

TABLE 7. COMPOSITION OF BUTTER AS INFLUENCED BY TIME THE CREAM IS HELD AT CHURNING TEMPERATURE—26 CHURNINGS

	Samples taken from								
	Butter in the churn			Fifty tubs before storage			Same tubs after storage		
	Percent			Percent			Percent		
	Water	Fat	Salt	Water	Fat	Salt	Water	Fat	Salt
From cream held 1 to 3 hours.	13.86	82.32	3.08	12.99	83.39	2.91	12.04	84.56	2.63
From cream held 12 to 15 hours.	13.83	82.59	2.82	12.83	83.85	2.57	11.88	85.01	2.33

This table indicates that the length of time the cream is held at churning temperature is not a factor in controlling composition.

#### COMPOSITION OF BUTTER FROM PASTEURIZED AND UNPASTEURIZED CREAM

A series of experiments were carried on in 1907 and 1908 to determine the relation of pasteurization to quality of butter. The first year the butter from twenty-six churnings of pasteurized cream was compared with the butter made from the same number of churnings of unpasteurized cream.

In the fourteen comparisons the cream for each day's experiment was all mixed in one vat, one half of this was pasteurized and placed in a ripener, the other half was placed in the ripener, unpasteurized. For two days, the cream in each ripener was churned in a single churning. On the other twelve days the cream in each ripener was divided and churned in two churnings, making a total of four churnings each day for twelve days and two churnings a day for two days.

Two tubs of butter were packed from each churning, making a total of 104 tubs for the two lots, or 52 tubs of butter made from pasteurized cream, compared with fifty-two tubs of butter made from unpasteurized cream. Samples for analysis were taken from the churn and from the tubs before and after storage. The averages of the results obtained by analyzing these samples are shown in the following table:

TABLE 8. COMPOSITION OF BUTTER MADE FROM PASTEURIZED AND UNPASTEURIZED CREAM—26 CHURNINGS EACH

	Unpasteurized			Pasteurized		
	Samples taken from			Samples taken from		
	Churn	52 tubs before storage	Same tubs after storage	Churn	52 tubs before storage	Same tubs after storage
Water	14.42	13.31	12.24	13.63	12.66	11.76
Fat ...	81.67	82.99	84.39	82.69	83.98	85.04
Salt ..	3.07	2.87	2.56	2.98	2.61	2.39

The butter fat in each individual sample taken from tub, before storage, is also recorded in Table 18.

The above table also indicates the change in composition due to the length of time the butter was held before samples were taken.

In 1908, samples of butter for analyses were taken from forty churnings, made from pasteurized cream. Twenty of these churnings were made to contain a high percent of water and low percent of fat. In the other twenty churnings the butter contained low water and high fat. For churning record see Table 12.

Twenty-four hours after churning, the samples of butter were taken from four tubs packed from each churn, making a total of 80 samples taken from tubs of pasteurized butter, containing high water and low fat, and 80 from butter of a low water and high fat content. Samples were again taken from the butter in two of these tubs from each churning after six to seven months in storage. In like manner, samples were taken from the butter made from corresponding lots of unpasteurized cream.

Results of analyzing each of these samples are recorded in Table 13. Samples from churn 1, tubs 201 and 203, 401 and 403 before storage, and tubs 201 and 203 after storage, represent high water and low fat butter; churn 2, tubs 202, 204, 402 and 404 before storage, and 202 and 204 after storage represent the low water and high fat butter made from the same vats of cream pasteurized. Churn 3, tubs 205, 207, 405 and 407 before storage, and 205, 207 after storage; churn 4, tubs 206, 208, 406 and 408 before storage, and 206, 208, after storage represent the high water and low fat, and low water and high fat butter from unpasteurized cream. Each division of four churns represents a complete comparison.

Table 9 gives the comparison of the water, fat, and salt content separately for the two kinds of butter made from pasteurized and unpasteurized cream.

TABLE 9. INFLUENCE OF PASTEURIZATION OF CREAM UPON COMPOSITION OF BUTTER.

Comparing the Butter on basis of percent of Water in the High Water and Low Fat Content Butter—20 churnings

Churn No.	Samples taken from churn			Samples taken from 4 tubs before storage		Samples taken from 2 of these tubs after storage	
	Pasteurized	Churn No.	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
1	15.28	3	14.23	13.61	12.99	13.58	12.33
5	14.98	7	14.71	13.98	13.71	13.17	12.86
9	15.19	11	15.51	14.31	14.95	14.04	13.56
13	15.57	15	16.05	14.56	14.62	13.38	13.56
17	15.05	19	15.13	13.95	13.84	13.23	13.38
21	15.26	23	14.93	14.03	13.91	13.68	13.05
25	15.52	27	15.78	15.30	14.03	15.33	13.67
9	15.04	3	14.62	14.19	14.89	14.04	13.38
33	15.04	35	14.95	14.71	14.50	13.82	13.97
37	16.13	39	14.88	15.53	13.90	14.75	12.41
41	16.64	43	15.37	16.12	15.35	14.39	14.35
45	15.66	47	15.44	14.77	14.81	14.25	13.84
49	15.73	51	15.74	15.25	14.95	14.52	14.97
53	15.55	55	14.59	15.33	14.33	14.13	13.26
57	15.74	59	16.54	15.58	15.72	13.86	13.32
61	16.06	63	15.49	15.68	15.13	14.29	13.33
65	16.15	67	15.15	15.42	15.06	14.55	13.51
69	15.85	71	14.94	15.38	14.62	13.75	12.84
73	14.52	75	14.21	15.01	14.27	13.30	12.73
77	15.15	79	15.22	14.87	14.49	13.93	13.35
Av. ...	15.50		15.12	14.87	14.49	13.93	13.35
Dif. ...	0.38			0.38		0.58	

TABLE 9—Continued

Percent of Water in Low Water and High Fat Content Butter—20 churnings

Churn No.	Samples taken from churn			Samples taken from 4 tubs before storage		Samples taken from 2 of these tubs after storage	
	Pasteurized	Churn No.	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
2	13.09	4	12.75	12.25	11.69	11.16	11.13
6	13.09	8	13.97	12.34	12.49	11.51	11.34
10	12.87	12	14.42	12.17	12.39	11.30	12.63
14	13.29	16	13.87	12.20	12.69	11.77	11.71
18	12.80	20	13.22	11.82	12.17	11.41	11.48
22	13.10	24	13.43	12.16	12.52	11.61	11.48
26	13.30	28	14.15	12.76	13.35	11.39	11.53
30	12.97	32	13.24	12.54	12.98	11.36	11.63
34	12.26	36	13.20	12.09	12.64	11.46	11.80
38	12.88	40	13.37	12.21	11.23	11.28	10.88
42	12.69	44	12.59	12.10	13.15	10.56	12.01
46	13.50	48	13.32	12.30	11.96	11.17	10.06
50	13.89	52	13.31	12.97	12.84	12.03	11.74
54	13.22	56	13.31	13.26	12.90	11.86	13.01
58	13.01	60	13.48	12.65	13.12	11.65	12.26
62	14.49	64	13.39	13.70	13.18	12.25	11.89
66	14.14	68	12.94	13.16	12.92	11.79	11.32
70	13.59	72	13.21	12.87	12.95	11.68	11.45
74	12.80	76	13.08	12.55	12.75	11.35	11.53
78	13.59	80	13.19	13.76	13.51	12.02	12.11
Av. ...	13.22		13.42	12.59	12.52	11.53	11.67
Dif. ...			0.20	0.07			0.14

TABLE 9—Continued

Comparing the Butter on the Basis of Percent of Fat in the High Water and Low Fat Content Butter

Churn No.	Samples taken from churn			Samples taken from 4 tubs before storage		Samples taken from 2 of these tubs after storage	
	Pasteurized	Churn No.	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
1	80.81	3	82.66	83.24	84.29	83.04	84.97
5	81.03	7	82.12	82.58	83.02	83.44	84.08
9	80.51	11	80.42	82.13	81.16	82.20	82.85
13	80.06	15	80.33	81.43	82.13	82.63	83.25
17	80.42	19	80.63	81.93	82.23	82.61	82.84
21	81.15	23	82.12	82.84	83.50	83.08	84.34
25	81.25	27	80.75	81.47	82.91	82.61	83.33
29	80.88	31	82.52	81.98	82.16	82.12	83.96
33	81.38	35	82.31	81.59	82.80	82.79	83.30
37	80.06	39	81.98	81.07	83.40	82.00	84.93
41	79.59	43	81.60	80.40	81.72	82.38	82.74
45	80.89	47	81.60	81.88	82.29	82.42	83.23
49	80.29	51	80.42	80.94	81.51	81.63	81.24
53	81.61	55	82.83	81.84	83.19	83.24	84.40
57	81.05	59	79.18	81.03	80.11	83.03	83.12
61	80.39	63	81.38	80.73	81.89	82.51	83.80
65	80.67	67	82.02	81.23	82.31	82.52	83.98
69	81.02	71	82.22	81.19	82.48	83.59	84.78
73	82.67	75	81.89	81.79	81.84	81.13	83.79
77	82.26	79	83.46	82.27	82.02	84.02	85.02
Av. ...	80.89		81.62	81.68	82.35	82.80	83.69
Dif. ...			0.73		0.67		0.89

TABLE 9—Continued

Percent Fat in the Low Water and High Fat Content Butter

Churn No.	Samples taken from churn			Samples taken from 4 tubs before storage		Samples taken from 2 of these tubs after storage	
	Pasteurized	Churn No.	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
2	83.17	4	84.04	84.33	85.59	85.65	86.19
6	83.66	8	82.62	84.73	84.69	85.58	86.04
10	84.15	12	82.24	85.01	83.82	86.02	84.52
14	83.82	16	83.61	85.26	85.03	85.71	86.21
18	84.60	20	84.02	85.85	85.33	86.30	86.11
22	84.46	24	84.22	85.72	85.50	86.17	86.48
26	84.25	28	82.91	85.00	84.01	86.37	86.07
30	84.65	32	84.34	84.97	84.67	86.40	86.30
34	85.52	36	84.18	85.68	84.92	86.44	85.87
38	84.18	40	83.25	85.13	84.83	86.16	86.45
42	84.57	44	83.58	85.34	84.19	86.97	84.87
46	83.11	48	83.13	84.66	84.72	85.93	87.02
50	81.06	52	84.10	82.47	84.61	83.71	85.75
54	84.44	56	84.36	84.38	84.84	85.85	84.52
58	84.57	60	83.70	84.93	84.09	85.81	84.85
62	82.18	64	83.85	83.15	84.04	84.79	85.54
66	82.23	68	84.42	83.69	84.48	85.29	86.46
70	83.59	72	84.07	84.52	84.41	85.96	86.12
74	84.42	76	84.58	84.87	85.06	86.42	86.31
78	83.85	80	84.64	83.57	84.66	85.81	85.85
Av. ...	83.82		83.79	84.66	84.67	85.83	85.87
Dif. ...	0.03				0.01		0.04

TABLE 9—Continued

Comparing the Butter on the Basis of Percent of Salt in the High Water and Low Fat Content Butter

Churn No.	Samples taken from churn			Samples taken from 4 tubs before storage		Samples taken from 2 of these tubs after storage	
	Pasteurized	Churn No.	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
1	2.77	3	2.10	2.25	1.78	2.59	1.79
5	2.81	7	2.37	2.56	2.13	2.71	1.88
9	2.97	11	3.00	2.53	2.74	2.87	2.72
13	3.24	15	2.61	3.06	2.36	3.02	2.26
17	3.54	19	3.28	3.14	2.98	3.30	2.97
21	2.65	23	2.03	2.39	1.91	2.51	1.84
25	2.33	27	2.45	2.31	2.15	2.27	2.18
29	3.03	31	1.75	2.91	2.06	3.10	1.78
33	2.65	35	1.82	2.85	1.77	2.58	1.81
37	2.58	39	2.05	2.46	1.77	2.46	1.79
41	2.72	43	2.07	2.47	2.30	2.47	2.08
45	2.82	47	2.35	2.56	2.04	2.51	2.03
49	2.91	51	2.94	2.79	2.61	2.93	2.85
53	2.04	55	1.77	1.89	1.61	1.72	1.46
57	2.51	59	3.50	2.29	3.14	2.18	2.73
61	2.59	63	2.33	2.62	2.17	2.30	1.71
65	2.27	67	1.85	2.10	1.61	1.91	1.58
69	2.19	71	1.99	2.15	1.76	1.71	1.52
73	1.97	75	3.12	2.00	2.91	1.76	1.65
77	1.69	79	1.63	1.58	1.51	1.40	1.29
Av. . .	2.61		2.35	2.45	2.16	2.40	2.05
Dif. . .	0.26			0.29		0.35	

TABLE 9—Continued

Percent of Salt in the Low Water and High Fat Content Butter

Churn No.	Samples taken from churn			Samples taken from 4 tubs before storage		Samples taken from 2 of these tubs after storage	
	Pasteurized	Churn No.	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
2	2.82	4	2.21	2.45	1.84	2.48	1.92
6	2.30	8	2.10	2.12	1.92	2.20	1.76
10	2.18	12	2.13	1.92	1.77	1.97	1.94
14	2.03	16	1.78	1.90	1.51	1.93	1.38
18	1.76	20	1.93	1.65	1.64	1.66	1.58
22	1.65	24	1.54	1.58	1.59	1.61	1.30
26	1.68	28	2.01	1.66	1.82	1.58	1.56
30	1.67	32	1.47	1.78	1.56	1.54	1.28
34	1.39	36	1.60	1.71	1.75	1.42	1.49
38	1.93	40	2.26	1.91	1.99	1.75	1.83
42	2.05	44	1.81	2.02	1.67	1.79	1.82
46	2.75	48	2.86	2.17	2.32	2.09	2.00
50	3.90	52	1.85	3.65	1.66	3.36	1.63
54	1.79	56	1.68	1.57	1.68	1.50	1.56
58	1.93	60	2.21	1.78	2.02	1.75	2.02
62	2.68	64	2.05	2.41	1.86	2.09	1.67
66	2.69	68	1.88	2.31	1.71	2.07	1.42
70	1.98	72	1.80	1.78	1.58	1.58	1.54
74	1.78	76	1.55	1.70	1.68	1.50	1.28
78	1.77	80	1.41	1.66	1.59	1.37	1.23
Av. . .	2.14		1.91	1.97	1.71	1.86	1.61
Dif. . .	0.23			0.26		0.25	

TABLE 10. GENERAL SUMMARY OF PRECEDING TABLE

	Pasteurized—40 churnings			Unpasteurized—40 churnings		
	Samples taken from			Samples taken from		
	Churn	160 tubs before storage	80 tubs after storage	Churn	160 tubs before storage	80 tubs after storage
High Water and Low Fat Content Butter						
Percent water	15.50	14.87	13.93	15.12	14.49	13.35
“ fat ..	80.89	81.68	82.80	81.62	82.35	83.69
“ salt .	2.61	2.45	2.40	2.35	2.16	2.05
Difference between Pasteurized and Unpasteurized Butter						
Percent water	....	....	....	0.38	0.38	0.58
“ fat ..	0.73	0.67	0.89	....	....	....
“ salt .	....	....	....	0.26	0.29	0.35
Low Water and High Fat Content Butter						
Percent water	13.22	12.59	11.53	13.42	12.52	11.67
“ fat ..	83.82	84.66	85.83	83.79	84.67	85.87
“ salt .	2.14	1.97	1.86	1.91	1.71	1.61
Difference between Pasteurized and Unpasteurized Butter						
Percent water	0.20	....	0.14	....	0.07	....
“ fat ..	....	0.01	0.04	0.03	....	....
“ salt .	....	....	....	0.23	0.26	0.25

The unpasteurized butter in 1907 showed a higher water and lower fat content than did the butter from pasteurized cream. In 1908 when methods were employed that should give high and low water respectively, the butter from pasteurized cream contained higher water than the butter from unpasteurized cream. When the method was changed and butter containing high fat and low water was made there was little or no difference in the analysis of pasteurized and unpasteurized butter.

While averages would lead one to draw these conclusions there is no apparent regularity of distribution caused by churning either pasteurized or unpasteurized cream.

The foregoing Table is an excellent indication of what may be secured in uniformity of composition of butter from separate churnings, for with few exceptions, any of the above samples might have been one of ten taken from the same churning.

#### INFLUENCE OF DRY AND WET SALTING UPON COMPOSITION

Dry salting is the term applied to the usual method of salting butter. After the butter in the churn has been washed and the water allowed to drain the dry salt is then sprinkled uniformly over the surface.

Wet salting as here referred to is the method that has been used by this station during the past two years. It differs from the so-called

dry salting system in that more salt is required and a definite amount of water per pound of butter in the churn is also added. In either case the rate of salt used per pound of butter does not determine the percent of salt retained in the finished product. Dry salting, presupposes that some of the wash water is retained. This, however, is never constant nor in proportion to the amount of butter in the churn, hence, it is a factor largely responsible for lack of uniformity of salt content obtained by this method. A certain amount of water in the churn during working is necessary to aid in dissolving the salt. If this amount is not in proportion to the butter in the churn it will influence the amount of salt retained. For example, if 30 pounds of water should be left in the churn with the 200 or 600 pounds of butter and in either case salt added, at the rate of one ounce per pound of butter, it is natural that the butter in the 600 pound churn would contain the highest percent of salt, since a smaller percent of the salt is wasted in the form of brine, as previously stated.

By the wet method of salting, the butter is thoroughly drained and a definite amount of salt and water is added per pound of butter.

Thoroughly draining the butter, in a measure, overcomes the uncertain amount of water retained in the churn and leaves the relation of salt, butter, and water more definite.

An example of this method of salting is recorded in Table 12. The question naturally arises: What influence does this additional amount of water in the churn, while the butter is being worked, have upon the water and fat content?

TABLE 11. CHURN RECORD TO SHOW INFLUENCE OF DRY AND WET SALTING ON COMPOSITION OF BUTTER

Churn No.	Pounds					Percent		
	Cream	Butter fat	Salt added	Water added	Brine left in churn	Water	Fat	Salt
1.....	1016	243.8	33.5	51	78	15.05	81.80	2.32
2.....	923	226.3	16.5	not any	35	14.43	91.30	3.42
3.....	735	180.7	26.2	33	77	14.58	82.40	2.11
4.....	729	174.9	12.7	not any	37	14.94	82.26	2.01
5.....	807	229.8	16.5	not any	..	14.96	81.81	2.43
6.....	797	227.3	33.0	41	..	14.41	81.91	2.38
7.....	815	216.0	15.7	not any	22	14.33	82.14	2.78
8.....	740	196.1	28.6	36.6	60	13.73	82.38	3.19
9.....	700	189.0	27.5	34.5	82	14.46	82.35	2.41
10.....	690	186.0	13.7	not any	28	14.33	82.93	1.94
11.....	713	128.3	9.7	not any	50	13.73	84.53	0.93
12.....	651	117.8	17.1	21	62	14.05	83.42	1.80

This method of salting had been in use for some time before it was experimentally compared with dry salting on alternate days. This comparison did not indicate that the method of salting bore any direct relation to the intended water content. A year, or more, later comparisons were made on six consecutive days by dividing all of the cream



in the ripener into two churnings. Care was taken to eliminate all other influencing factors. In each series the butter was allowed to drain alike. To one churn was added one ounce of salt per pound of estimated butter and to the other two ounces of salt and two and one-half ounces of water per pound. The estimated butter was based upon pounds of butter fat churned allowing one-sixth for overrun.

In looking over these results there is a marked degree of uniformity in the water content, in fact, the variation would be no greater had all of the samples been taken from any one of the churnings. This is not so true of the fat and salt. In all the work that has previously been done at this station in studying composition, the data show that if a fixed percent of water is desired it can be obtained regardless of the amount of salt retained in the butter; that is to say, there is no relation between water and salt content. Casein also remains quite constant. It must therefore be noted that if butter is made having a high or low salt content, there must be a corresponding decrease or increase in fat content. Butter having 15 percent of water can be made regardless of whether the operator intends 1 or 5 percent of salt. Comparing the dry and wet salted butter for each day there is no great difference. The two lots of butter made in churnings 11 and 12 contained a much lower salt content due to the small amount of butter worked, in proportion to salt added, and excessive amounts of the wash water that was drained off, previous to salting. A comparatively uniform salt content can be maintained in various churnings of butter. The grains of salt can be distributed thru the butter regardless of whether they will dissolve or not. This fact may seem to be insignificant, but it is not a safe policy to make butter even under favorable conditions unless due consideration is given to the dissolving of salt. There is a difference in salt grains; some pass into solution much more readily than others. However, this difference can be reduced to a minimum by having some free water with the butter in the churn at time of working.

It may be observed by looking over Table 12, Churning Record, that the percent of salt was not as uniform as might be desired. It is also true that the ratio of salt and water used was not the same throughout the experiment. In churn number 75 an error was made in the salt calculation and was not discovered until the working was completed.

#### INFLUENCE OF TEMPERATURE UPON COMPOSITION

In connection with the regular investigation a large amount of data had been collected from time to time that might lead to some definite line of study on temperature as a factor influencing composition. Already some material had been obtained and was accumulating which gave temperature the most prominent place as a factor in controlling composition. Therefore it seemed advisable that a series of experiments be carried out on a large enough scale to furnish data comparable with practical creamery conditions. In connection with the work done in 1908 on comparing butter made from pasteurized

and unpasteurized cream the pasteurized cream for each day was placed in a 200 gallon cream ripener; the remainder of the cream for each comparison was not pasteurized but placed in another ripener, thus giving two different lots of cream from which to also study composition.

The pasteurized cream in each of the 20 comparisons was always churned first, in two different churns, and the unpasteurized cream immediately after. In each comparison the cream in the two ripeners was handled to produce butter having a high water and low fat content. The remainder of the cream in each ripener was made into butter of a low water and high fat content. The salt in these four churns was kept as nearly uniform as possible. Churns were numbered in order from 1 to 80. The first churn for each experimental day always contained pasteurized cream to be made into butter of high water and low fat, and second churn filled with the same cream but to be made into the drier butter. Preceding data showed that different makes of churns had an influence on the water content and this fact was taken advantage of in making high and low moisture butter. The only other change made to produce the two lots of butter of different composition, was the temperature of the wash water. However, it would have been possible to have secured a wider variation had the other lines of the experiment permitted a regulation of the temperature of the cream. The wash water was allowed to remain in the churn a sufficient length of time to adjust the temperature of the butter.



TABLE 12—Continued

	May 19		May 22		May 26		May 29		May 29	
	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
Weight of cream.....	1100 598	1100 587	1100 566	1100 596	1100 589	1100 574	1100 570	1100 533	570	1100 533
Percent fat.....	28. 28.	28. 28.	28.5 28.5	28.5 28.5	31.5 31.5	31.5 31.5	27. 27.	27. 27.	27. 27.	27. 27.
Pounds fat.....	308 167.4	308 164.4	313.5 161.3	313.5 169.5	346.5 185.5	346.5 180.8	297 154.	297 144.	154. 154.	297 144.
Acidity.....	0.50 0.50	0.55 0.55	0.54 0.54	0.52 0.52	0.45 0.45	0.54 0.54	0.54 0.54	0.55 0.55	0.54 0.54	0.55 0.55
Temperature.....	54 54	52 52	52 52	53 53	50 50	52 52	50 50	52 52	50 50	52 52
Hours held cold.....	3 3	5 5	3 3	5 5	6 6	4 4	6 6	4 4	6 6	4 4
Time to churn, minutes.....	17 18	27 27	23 20	25 25	20 20	18 15	17 17	25 20	.....	25 20
Weight of buttermilk.....	740 400	740 400	740 378	740 400	700 360	700 364	750 390	750 365	390 750	750 365
Percent fat in ".....	0.18 0.20	0.12 0.13	0.13 0.14	0.20 0.14	0.23 0.18	0.15 0.17	0.13 0.18	0.13 0.21	0.13 0.18	0.13 0.21
Pounds fat in ".....	1.33 0.80	0.88 0.52	0.96 0.53	1.48 0.56	1.61 0.85	1.05 0.79	0.97 0.70	0.97 0.76	0.97 0.70	0.97 0.76
Temperature.....	58 59	55.5 55	58 58	56 55	56 56	57 59	55 55	58 59	55 55	58 59
Weight wash water.....	740 400	740 400	740 378	740 408	700 360	700 364	750 390	750 366	750 390	750 366
Temperature wash water.....	60 47	60 47	60 47	60 47	58 48	58 48	48 48	58 48	48 48	58 48
Weight of salt.....	44.9 24.4	44.9 23.9	40 20.5	40 21.8	44 23.7	44 23	44 20	37 18 1/2	44 20	37 18 1/2
Rate per pound butter.....	2 oz. 2 oz.	2 oz. 2 oz.	1 1/2 oz. 1 1/2 oz.	1 1/2 oz. 1 1/2 oz.	1 1/2 oz. 1 1/2 oz.	1 1/2 oz. 1 1/2 oz.	2 oz. 1 1/2 oz.	1 1/2 oz. 1 1/2 oz.	1 1/2 oz. 1 1/2 oz.	1 1/2 oz. 1 1/2 oz.
Weight water to salt.....	67.2 36.6	67.2 36.	68 34.6	68 36	76 40.5	76 40	76 33 1/2	65 31.5	76 33 1/2	65 31.5
Rate per pound butter.....	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.	3 oz. 3 oz.
Number times worked.....	12 18	12 18	12 18	12 18	12 12	12 18	12 18	12 18	12 18	12 18
Temperature of butter.....	61 54	59 52	60 54	58.5 49	59 52	58 53	58 54	57 52 1/2	58 54	57 52 1/2
Weight of butter.....	376 193	375.5 190	386 197.5	390 205	424 223	420 215	358 178	258 167	358 178	258 167
Percent overrun.....	22.1 15.3	21.9 15.5	23.1 22.4	24.4 20.7	22.3 20.2	21.2 18.9	20.5 15.6	20.5 16.	20.5 15.6	20.5 16.
Weight starter.....	(250)	(254)	(236)	(236)	(None)	(None)	(212)	(212)	(212)	(212)
Churn used.....	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow
Churn number.....	17 18	19 20	21 22	23 24	25 26	27 28	29 30	31 32	30 31	32 32
Tub numbers.....	233 234	237 238	241 242	245 246	249 250	253 254	257 258	261 262	257 258	261 262
".....	235 236	239 240	243 244	247 248	251 252	255 256	259 260	263 264	259 260	263 264
".....	433 434	437 438	441 442	445 446	449 450	453 454	457 458	461 462	457 458	461 462
".....	435 436	439 440	443 444	447 448	451 452	455 456	459 460	461 462	459 460	461 462

TABLE 12—Continued

	June 2		June 2		June 5		June 5		June 9		June 9		June 12		June 12	
	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
Weight of cream.....	1100	509	1100	551	1100	571	1100	659	1100	666	1100	621	1100	580	1100	580
Percent fat.....	32	32	32	32	32	32	32.5	32.5	32.5	32.5	32.5	32.5	32.5	32.	32.	32.
Pounds fat.....	352	164.8	352	176.3	352	182.7	357.5	214.1	357.5	216.5	352	198.7	352	185.6	352	185.6
Acidity.....	0.46	0.50	0.50	0.52	0.52	0.57	0.50	0.50	0.54	0.54	0.43	0.43	0.43	0.49	0.49	0.49
Temperature.....	47	50	50	47	49	49	51	51	53	53	50	50	50	51	51	51
Hours held cold.....	3	5	5	3	3	5	3	3	5	5	3	3	3	5	5	5
Time to churn, minutes.....	42	30	35	40	45	40	20	24	20	20	27	23	35	30	30	30
Weight of buttermilk.....	700	320	700	340	700	360	680	400	680	400	670	385	670	360	670	360
Percent fat in ".....	0.08	0.07	0.10	0.10	0.12	0.14	0.22	0.20	0.27	0.22	0.28	0.20	0.17	0.20	0.17	0.20
Pounds fat in ".....	0.56	0.22	0.70	0.40	0.98	0.54	1.49	0.80	1.83	0.88	1.87	0.77	1.14	0.72	1.14	0.72
Temperature of ".....	54	54	57	54	56	56	56	56	57	57	56	56	56	56	56	56
Weight wash water.....	700	320	700	340	700	360	680	400	680	400	670	385	670	360	670	360
Temperature wash water.....	58	52	58	52	58	48	58	48	58	48	58	48	58	48	58	48
Weight of salt.....	45	21	45	25.5	45	36.6	45.5	31½	45.5	31½	45	29	45	27	45	27
Rate per pound butter.....	1½ oz.	1½ oz.	1½ oz.	2 oz.	1½ oz.	2 oz.	1½ oz.	2 oz.	1½ oz.	1½ oz.	1½ oz.	2 oz.	1½ oz.	2 oz.	1½ oz.	2 oz.
Weight water to salt.....	77	36	77	39	77	40	78	47	78	47.5	77	43	77	41	77	41
Rate per pound butter.....	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.
Number times worked.....	12	18	12	18	12	18	12	18	12	18	12	18	12	18	12	18
Temperature of butter.....	57	49	57	55	59	54	58	50	58	53	58	52	58	51	58	51
Weight of butter.....	432.5	196	426	433	210.5	214	453	255.5	438	265.5	428	237	432.5	221.5	432.5	221.5
Percent overrun.....	22.8	18.9	21	23	19.4	17.1	26.6	19.3	22.5	22.7	21.4	19.2	22.8	19.3	22.8	19.3
Weight starter.....	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)	(None)
Churn used.....	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow
Churn number.....	33	34	35	36	37	40	41	42	43	44	45	46	47	48	47	48
Tab numbers.....	265	266	269	270	273	274	277	281	282	285	286	289	290	293	294	294
".....	267	268	271	272	275	280	283	284	287	288	291	292	295	296	295	296
".....	465	466	469	470	473	474	477	481	482	485	486	489	490	493	494	494
".....	467	468	471	472	475	480	483	484	487	488	491	492	495	496	495	496

TABLE 12—Continued

	June 16		June 18		June 19		June 23		June 23	
	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
Weight of cream.....	1100	539	900	495	1100	616	1100	616	1100	568
Percent fat.....	27.5	27.5	24.5	24.5	26.5	26.5	26.5	26.5	26.5	26.5
Pounds fat.....	302.5	148.2	220.5	121.3	291.5	163.2	291.5	163.2	291.5	150.5
Acidity.....	0.46	0.5	0.54	0.50	0.5	0.5	0.52	0.46	0.46	0.48
Temperature.....	49.5	49.5	49	50	51	51	49	50	50	50
Hours held cold.....	3	5	3	5	3	3	.0	3	3	5
Time to churn, minutes.....	45	50	27	25	30	30	30	30	30	30
Weight of buttermilk.....	725	370	635	350	750	425	750	400	750	390
Percent fat in ".....	0.28	0.15	0.18	0.15	0.17	0.17	0.25	0.25	0.20	0.24
Pounds fat in ".....	2.03	1.09	0.95	0.63	1.27	0.72	1.87	1.00	1.2	1.82
Temperature.....	56	55	58	57	58	58	57	58	58	57
Weight of wash water.....	725	370	635	350	750	425	750	400	750	390
Temperature wash water.....	59	48	59	49	58	50	58	50	58	48
Weight of salt.....	45	28.5	32	17.5	43½	24	43½	24	43½	22
Rate per pound butter.....	2 oz.	2½ oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.
Weight water to salt.....	66	33.5	48	26	66	30	66	30	66	27.5
Rate per pound butter.....	3 oz.	3 oz.	3 oz.	3 oz.	3 oz.	2½ oz.	3 oz.	2½ oz.	3 oz.	2½ oz.
Number times worked.....	12	28	12	23	12	18	12	18	12	20
Temperature of butter.....	58	50	59	52	59	54	59	54	59	52
Weight of butter.....	375	190	371	173.5	265	145	351	191	355	195
Percent overrun.....	24.	24.	20.1	17.7	20.4	17	22.4	17.7	21.7	18.2
Weight starter.....	(271)	(271)	(282)	(282)	(168)	(168)	(168)	(168)	(240)	(240)
Churn used.....	Victor	Dishrow	Victor	Dishrow	Victor	Dishrow	Victor	Dishrow	Victor	Dishrow
Churn number.....	49	50	53	55	57	58	59	60	61	62
Tub numbers.....	297	298	301	302	305	306	310	313	314	318
".....	299	300	303	304	307	308	311	312	315	316
".....	497	498	501	502	505	506	509	510	513	514
".....	499	500	503	504	507	508	511	512	515	516

TABLE 12—Continued

	June 25		June 26		June 26		June 30		June 30		July 1		July 1	
	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized	Pasteurized	Unpasteurized
Weight of cream.....	800	730	1000	1000	536	536	750	450	750	450	700	535	700	523
Percent fat.....	25.5	25.	24.5	24.5	24.5	24.5	27.5	27.5	27.5	27.5	24.	24.	24.5	24.5
Pounds fat.....	204	182.5	245	245	131.3	131.3	206½	123½	206½	123½	168	128.4	171.5	128
Acidity.....	0.52	0.57	0.46	0.50	0.50	0.50	0.45	0.45	0.50	0.50	0.49	0.49	0.55	0.55
Temperature.....	50	52	50	52	52	52	49	49	48	48	46	46	49	49
Hours held cold.....	3	5	2	4	4	4	3	3	5	5	12	12	14	14
Time to churn, minutes.....	25	20	35	35	.....	.....	25	25	30	30	38	40	35	35½
Weight of buttermilk.....	550	400	800	800	385	385	500	300	500	300	500	400	500	370
Per cent fat in ".....	0.27	0.23	0.15	0.15	0.18	0.15	0.07	0.06	0.14	0.11	0.13	0.1	0.12	0.09
Pounds fat in ".....	1.48	0.92	1.60	1.08	0.68	0.68	0.35	0.18	0.70	0.33	0.65	0.40	0.60	0.33
Temperature.....	58	57	59	58	58	58	56	57	56	56	54	54	54	54
Weight of wash water.....	550	400	800	800	385	385	500	300	500	300	500	400	500	370
Temperature.....	58	48	58	48	58	48	59	50	60	50	61	49	61	49
Weight of salt.....	29½	21½	35½	35½	19½	19½	30	19	30	19	24	18½	25	18½
Rate per pound butter.....	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.	2 oz.
Weight water to salt.....	44.5	27	41	24.3	54	24	45	24	24	24	30	18½	31	18½
Rate per pound butter.....	3 oz.	2.5oz.	3 oz.	2.5oz.	3 oz.	2.5oz.	3 oz.	3½ oz.	3 oz.	2½ oz.	2½ oz.	2½ oz.	2½ oz.	2½ oz.
Number times worked.....	12	18	12	18	12	18	12	18	12	18	12	18	12	18
Temperature of butter.....	58	54	59	53	58	53	56	52	59	56	60	52	59	52
Weight of butter.....	254½	175½	224	159	294	157	244	144	246	144	199	156	202	52
Percent overrun.....	24.7	19.4	22.7	19.1	20.	18.5	18.3	16.4	19.3	16.4	18.5	21.5	17.7	18.8
Weight starter.....	(283)	(283)	(286)	(286)	(286)	(286)	(142)	(142)	(142)	(142)	(150)	(150)	(150)	(150)
Churn used.....	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow	Victor	Disbrow
Churn numbers.....	65	66	67	68	69	70	73	74	75	76	77	78	79	80
Tub numbers.....	329	330	333	334	337	338	345	346	349	350	353	354	357	358
".....	331	332	335	336	339	340	347	348	351	352	355	356	359	360
".....	529	530	533	534	537	538	545	546	549	550	553	554	557	558
".....	531	532	535	536	539	540	547	548	551	552	555	556	559	560

Table 12 is a complete record of the method of making the 80 consecutive churnings of experimental butter, for comparison of pasteurized and unpasteurized cream, and of high and low water content butter. In making butter in a creamery the general method need vary but little from this, except in respect to temperature of the water used in washing and the amount of salt and water added at time of salting. This butter was made during the months of May and June. The temperature of the cream and the length of time it was held before churning gave results that were desirable. The temperature of the wash water was constant, depending upon composition intended in the butter. There was a difference in the general condition of the two lots of butter commensurate with the method of handling, but this difference was not sufficient to be detected when the butter was judged. The lots of butter made to contain the higher percent of water were rather soft when the working was completed and the low water butter very firm. This condition was due to the temperature of the wash water alone.

It is interesting to note that the sudden change of temperature in the butter, due to washing it with water at a much lower or a much higher temperature than that of the buttermilk, did not impair the finished workmanship. It was the unanimous opinion of the judges that the workmanship could not have been improved.

The range of temperature that should be employed in handling cream during the various stages until it is made into butter, cannot be stated definitely. The general method followed in Table 12 produces desirable results during the summer months in Illinois. The main change of temperature occurs as the season advances. This general method employed in salting the butter gives desirable results. The objection is that salt is wasted; however, it is not necessary that 2 ounces of salt and 3 ounces of water per pound of butter be the standard. The presence of a given amount of water in the churn to dissolve the salt reduces the possibility of mottles. Mr. F. A. Jorgensen, Field Instructor in Dairy Manufactures, has in his work in the creameries, used less salt and water. This same method has been given a thoro trial in making butter in the University creamery and proves to be nearly as successful. In this method the amount of butter is estimated on the basis of butter fat in the cream plus one-sixth for overrun. To every one hundred pounds of butter add 8 to 10 pounds of salt and 8 to 12 pounds of water. Mix the granular butter, salt and water by revolving the churn on slow gear ten revolutions, then work the usual amount.

The only reason for advocating the two different methods of salting butter is that the creamery operator may have some standard. However, the skilled operator needs no better method than the one he has followed for years.

In referring to churn 1 on May 6, it can be seen that the representative tubs packed were marked 201, 203, 401, and 403. These same tub numbers are used again in Table 13, also in Table 15, to show the amount of butter fat recovered in the butter made in churn 1. The



first average in Table 17 represents the first four churnings in Table 12 and the first sixteen tubs sampled and reported in Table 13.

Samples for analysis were taken from the churn, from four tubs packed from each churning and from two of these tubs from each churning after storage.

It seemed best to give the results obtained by analyzing each sample together with averages in order that further data are furnished to show: (1) That uniformity of composition is possible regardless of the percent of water or fat intended to be put into the butter. (2) The sampling of four different tubs from the same churn does not always give samples having the same composition. (3) Variation in composition of butter when samples are taken from the butter in the churn and in the tubs before and after storage. It was not intended that butter with abnormally high, or with an illegal percent of water, be made, but a grade of butter that could be sold on any market.

The two lots of butter naturally did not have the same degree of firmness when packed into the tubs and the hard butter did not handle quite as well nor show as finished workmanship as the soft butter but there was not enough difference to affect its market or general condition for judging.

The results obtained by studying influence of temperature are not abnormal. Butter fat does not at all seasons of the year respond alike to the same temperature. This is not new information since creamery operators have long had an adjustable scale of temperature to suit seasons of the year. There is no excuse for illegal butter in any locality. It is true, that there are minor influencing factors to be recognized, all of which may be controlled by temperature.

TABLE 13. COMPOSITION OF BUTTER IN EIGHTY CONSECUTIVE CHURNINGS. WHEN SAMPLES ARE TAKEN FROM CHURN; FROM FOUR TUBS FROM EACH CHURNING TWENTY-FOUR HOURS LATER, AND FROM TWO OF THESE SAME TUBS AFTER SIX TO SEVEN MONTHS IN STORAGE

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage			
		Percent				Percent				Percent			
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
201	1	15.28	80.81	2.77	1.14	13.36	83.45	2.22	0.97	13.95	82.56	2.69	0.80
203						13.53	83.28	2.25	0.94	13.20	83.52	2.48	0.80
401						13.93	82.98	2.29	0.80				
403						13.62	83.27	2.24	0.87				
202	2	13.09	83.17	2.82	0.92	12.01	84.70	2.43	0.86	11.05	85.83	2.48	0.64
204						12.29	84.25	2.47	0.99	11.27	85.46	2.48	0.79
402						12.50	84.02	2.52	0.96				
404						12.20	84.37	2.39	1.04				
205	3	14.23	82.66	2.10	1.01	13.01	84.37	1.87	0.75	12.47	84.80	1.78	0.95
207						12.65	84.65	1.68	1.02	12.18	85.13	1.80	0.89
405						13.44	83.73	1.89	0.94				
405						12.87	84.43	1.68	1.02				
206	4	12.75	84.04	2.21	1.00	11.55	85.82	1.82	0.81	10.86	86.55	1.87	0.72
208						11.71	85.50	1.91	0.88	11.39	85.83	1.97	0.81
406						11.88	85.30	1.88	0.94				
408						11.63	85.72	1.74	0.91				
209	5	14.98	81.03	2.81	1.18	13.88	82.74	2.49	0.89	13.32	83.19	2.68	0.81
211						13.69	82.94	2.47	0.90	13.02	83.69	2.54	0.75
409						14.54	81.82	2.66	0.98				
411						13.70	82.85	2.63	0.82				
210	6	13.09	83.66	2.30	0.95	12.40	84.72	2.13	0.75	11.88	85.22	2.24	0.66
212						12.30	84.78	2.05	0.87	11.13	85.94	2.16	0.77
410						12.34	84.66	2.12	0.88				
412						12.32	84.76	2.17	0.75				
213	7	14.71	82.12	2.27	0.90	13.77	83.01	2.10	1.12	12.80	84.12	1.63	1.46
215						13.45	83.18	2.17	1.20	12.92	84.03	2.14	0.91
413						13.48	83.39	2.10	1.03				
415						14.16	82.51	2.14	1.19				
214	8	13.97	82.62	2.10	1.31	12.37	84.96	1.74	0.93	11.35	86.02	1.76	0.97
216						12.73	84.28	1.89	1.10	11.32	86.05	1.76	0.87
414						12.40	84.86	2.10	0.64				
416						12.48	84.66	1.96	0.90				
217	9	15.19	80.51	2.97	1.33	14.39	81.90	2.60	1.11	13.93	82.07	2.97	1.03
219						13.98	82.77	2.36	0.89	14.14	82.32	2.76	0.78
417						14.23	82.11	2.51	1.15				
419						14.62	81.74	2.66	0.98				
218	10	12.87	84.15	2.18	0.80	12.57	84.61	2.08	0.74	11.10	86.28	1.91	0.71
220						12.08	85.14	1.89	0.89	11.49	85.76	2.02	0.73
418						12.17	84.93	1.87	1.13				
420						11.87	85.38	1.86	0.89				

TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage							
		Percent				Percent				Percent							
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein				
221	11	15.51	80.42	3.00	1.07	14.98	81.02	2.86	1.14	14.01	82.16	2.87	0.96				
223						15.03	81.09	2.71	1.17					12.95	83.54	2.57	0.84
421						14.93	81.21	2.66	1.20								
423						14.88	81.34	2.74	1.04								
222	12	14.42	82.24	2.13	1.21	13.36	83.86	1.80	0.98	12.94	84.12	2.04	0.90				
224						13.51	83.53	1.84	1.12					12.31	84.96	1.83	0.90
422						13.32	83.95	1.71	1.02								
424						13.36	83.96	1.73	0.95								
225	13	15.57	80.06	3.24	1.13	14.13	82.03	3.02	0.82	13.46	82.63	3.09	0.80				
227						14.29	81.88	2.67	1.16					13.29	82.60	2.95	1.16
425						14.15	81.89	3.00	0.96								
427						15.69	79.94	3.54	0.83								
226	14	13.29	83.82	2.03	0.86	12.11	85.52	1.86	0.51	11.77	85.85	1.92	0.66				
228						11.93	85.54	1.87	0.66					11.76	85.77	1.94	0.53
426						12.42	85.00	1.91	0.67								
428						12.34	84.98	1.97	0.71								
229	15	16.05	80.33	2.61	1.01	14.08	82.86	2.22	0.84	13.96	82.83	2.36	0.85				
231						14.45	82.38	2.28	0.89					13.35	83.67	2.15	0.83
429						14.92	81.80	2.45	0.83								
431						15.03	81.47	2.49	1.01								
230	16	13.87	83.61	1.78	0.74	12.24	85.58	1.51	0.67	11.80	86.07	1.42	0.71				
232						12.47	85.32	1.44	0.77					11.62	86.35	1.34	0.69
430						13.02	84.64	1.59	0.75								
432						13.02	84.57	1.49	0.92								
233	17	15.05	80.42	3.54	0.99	14.03	81.77	3.19	1.01	13.03	82.90	3.14	0.93				
235						13.60	82.38	3.00	1.02					13.43	82.31	3.45	0.81
433						13.94	81.97	3.16	0.93								
435						14.22	81.62	3.18	0.98								
234	18	12.80	84.60	1.76	0.84	12.04	86.10	1.58	0.28	11.39	86.29	1.67	0.65				
236						11.63	85.59	1.66	1.02					11.42	86.30	1.64	0.64
434						11.89	85.68	1.72	0.71								
436						11.74	86.04	1.65	0.57								
237	19	15.13	80.63	3.28	0.96	13.99	82.05	3.00	0.96	13.57	82.57	3.05	0.81				
239						13.72	82.35	2.94	0.99					13.19	83.11	2.88	0.82
437						13.93	82.18	3.04	0.85								
439						13.71	82.34	2.94	1.01								
238	20	13.22	84.02	1.93	0.83	12.25	85.15	1.72	0.88	11.41	86.22	1.58	0.79				
240						11.97	85.61	1.64	0.78					11.55	86.00	1.58	0.87
438						12.29	85.28	1.68	0.75								
440						12.17	85.31	1.52	1.00								
241	21	15.26	81.15	2.65	0.94	13.94	82.99	2.28	0.79	13.35	83.51	2.43	0.71				
243						13.47	83.59	2.27	0.67					14.01	82.65	2.58	0.76
441						14.00	82.81	2.46	0.73								
443						14.70	81.98	2.56	0.76								

TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage			
		Percent				Percent				Percent			
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
242	22	13.10	84.46	1.65	0.79	12.36	85.46	1.60	0.58	11.46	86.32	1.60	0.62
244						12.02	85.91	1.58	0.49	11.75	86.01	1.62	0.62
442						12.23	85.59	1.66	0.52				
444						12.06	85.93	1.47	0.54				
245	23	14.93	82.12	2.03	0.92	13.84	83.37	1.89	0.90	12.74	84.71	1.72	0.83
247						13.95	83.58	1.88	0.59	13.35	83.97	1.96	0.72
445						13.81	83.70	1.91	0.58				
447						14.04	83.35	1.96	0.65				
246	24	13.43	84.22	1.54	0.81	12.60	85.46	1.34	0.60	11.09	86.81	1.30	0.80
248						12.94	85.34	1.44	0.28	11.86	86.15	1.29	0.70
446						12.10	85.95	1.26	0.69				
448						12.47	85.26	1.32	0.95				
249	25	15.52	81.25	2.33	0.90	15.48	81.08	2.37	1.07	14.36	82.59	2.23	0.81
251						14.92	81.96	2.20	0.92	14.29	82.62	2.31	0.78
449						15.18	81.73	2.26	0.92				
451						15.62	81.11	2.41	0.86				
250	26	13.30	84.25	1.68	0.77	12.77	85.20	1.60	0.43	10.69	86.95	1.58	0.78
252						12.90	84.80	1.73	0.57	12.09	85.58	1.58	0.85
450						12.73	85.02	1.66	0.59				
452						12.63	85.01	1.65	0.71				
253	27	15.78	80.75	2.45	1.02	13.97	83.27	2.01	0.76	13.81	83.17	2.17	0.85
255						12.59	84.27	2.11	1.03	13.52	83.49	2.19	0.80
453						14.67	82.22	2.18	0.93				
455						14.88	81.91	2.29	0.92				
254	28	14.15	82.91	2.01	0.93	13.48	83.99	1.84	0.69	11.52	86.03	1.59	0.86
256						13.64	83.55	1.94	0.87	11.53	86.10	1.53	0.84
454						13.31	84.12	1.76	0.81				
456						12.99	84.40	1.75	0.86				
257	29	15.04	80.68	3.03	1.25	14.52	81.52	3.03	0.93	14.06	81.99	3.21	0.74
259						13.94	82.46	2.73	0.87	14.01	82.24	2.99	0.76
457						14.21	81.85	2.95	0.99				
459						14.08	82.09	2.93	0.90				
258	30	12.97	84.65	1.67	0.71	12.71	84.81	1.84	0.64	11.48	86.26	1.53	0.73
260						12.32	85.29	1.64	0.75	11.23	86.53	1.54	0.70
458						12.34	85.10	1.64	0.92				
460						12.80	84.67	1.89	0.64				
261	31	14.62	82.52	1.76	1.10	14.53	82.71	1.90	0.86	13.49	83.90	1.85	0.76
263						15.17	81.69	2.21	0.93	13.26	84.01	1.73	1.03
461						14.93	82.05	2.05	0.97				
463						14.92	82.19	2.06	0.83				
262	32	13.24	84.34	1.47	0.95	12.59	85.23	1.50	0.68	11.35	86.70	1.27	0.68
264						13.09	84.35	1.69	0.87	11.90	85.90	1.29	0.91
462						13.11	84.55	1.39	0.95				
464						13.12	84.55	1.66	0.67				

TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage				
		Percent				Percent				Percent				
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	
265	33	15.04	81.38	2.65	0.93	14.68	81.75	2.78	0.79	13.81	82.76	2.61	0.82	
267						14.75	81.59	2.79	0.87	13.82	82.81	2.54	0.83	
465						15.38	80.73	3.12	0.77					
467						14.04	82.29	2.73	0.94					
266	34	12.26	85.52	1.39	0.83	12.14	85.58	1.49	0.79	11.51	86.28	1.44	0.77	
268						12.29	85.42	1.53	0.76	11.41	86.59	1.40	0.60	
466						12.00	85.78	1.46	0.76					
468						11.93	85.93	1.34	0.80					
269	35	14.95	82.31	1.82	0.92	14.78	82.66	1.78	0.78	13.96	83.37	1.78	0.89	
271						14.47	82.79	1.81	0.93	13.97	83.23	1.83	0.97	
469						14.84	82.30	1.82	1.04					
471						13.92	83.46	1.68	0.94					
270	36	13.20	84.18	1.60	1.02	12.42	85.22	1.51	0.85	11.82	85.82	1.47	0.89	
272						12.47	85.07	1.54	0.92	11.77	85.91	1.51	0.81	
470						12.72	84.81	1.34	1.13					
472						12.94	84.58	1.60	0.88					
273	37	16.13	80.06	2.58	1.23	15.57	80.98	2.22	1.23	14.43	82.35	2.39	0.83	
275						15.26	81.43	2.37	0.94	15.06	81.64	2.52	0.83	
473						15.69	80.87	2.60	0.84					
475						15.61	81.00	2.66	0.73					
274	38	12.88	84.18	1.93	1.01	11.85	85.41	2.01	0.73	11.16	86.18	1.81	0.85	
276						12.20	85.24	1.75	0.81	11.42	86.14	1.69	0.75	
474						12.38	84.93	1.95	0.74					
476						12.42	84.93	1.95	0.70					
277	39	14.88	81.98	2.05	1.09	13.73	83.64	1.54	1.10	12.03	85.37	1.71	0.89	
279						13.92	83.31	1.83	0.94	12.78	84.49	1.86	0.87	
477						14.00	83.35	1.83	0.82					
479						13.95	83.31	1.89	0.85					
278	40	13.37	83.25	2.26	1.12	12.48	84.71	1.86	0.95	10.85	86.61	1.71	0.83	
280						12.10	84.91	2.01	0.98	10.91	86.28	1.95	0.86	
478						12.18	84.93	1.94	0.95					
480						12.06	84.76	2.18	1.00					
281	41	16.64	79.59	2.72	1.05	15.28	81.38	2.36	0.98	14.33	82.49	2.45	0.73	
283						16.65	79.73	2.86	0.76	14.45	82.26	2.49	0.80	
481						16.36	80.13	2.79	0.72					
483						16.21	80.36	2.67	0.76					
282	42	12.69	84.57	2.05	0.69	11.86	85.56	1.95	0.63	10.57	86.97	1.79	0.67	
284						12.62	84.67	2.24	0.47	10.55	86.96	1.78	0.71	
482						12.03	85.48	1.96	0.58					
484						11.90	85.66	1.92	0.52					
285	43	15.37	81.60	2.07	0.96	15.85	81.10	2.36	0.69	14.60	82.38	2.14	0.87	
287						15.24	81.83	2.23	0.70	14.09	83.10	2.01	0.80	
485						15.30	81.80	2.39	0.51					
487						15.03	82.14	2.19	0.64					

TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage							
		Percent				Percent				Percent							
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein				
286	44	13.59	83.58	1.81	1.02	12.96	84.51	1.84	0.69	13.32	83.86	2.02	0.80				
288						13.38	83.73	1.97	0.92					11.71	85.88	1.61	0.80
486						13.23	84.07	1.89	0.81								
488						13.03	84.45	1.89	0.63								
289	45	15.66	80.89	2.82	0.63	14.18	82.58	2.49	0.75	14.09	82.61	2.46	0.84				
291						15.24	81.60	2.73	0.43					14.40	82.20	2.56	0.84
489						14.56	81.83	2.44	1.17								
491						15.10	81.52	2.59	0.79								
290	46	13.50	83.11	2.75	0.64	12.65	84.66	2.26	0.43	11.28	85.82	2.13	0.77				
292						12.52	84.36	2.07	1.05					11.06	86.04	2.05	0.85
490						11.99	85.00	2.20	0.81								
492						12.04	84.62	2.15	1.19								
293	47	15.44	81.60	2.35	0.61	15.10	81.89	2.16	0.85	14.03	82.93	2.10	0.94				
295						14.47	82.63	1.90	1.00					13.65	83.53	1.95	0.87
493						14.85	82.33	2.05	0.77								
495						14.82	82.30	2.05	0.83								
294	48	13.32	83.13	2.86	0.69	12.08	84.60	2.32	1.00	10.21	86.81	2.02	0.96				
296						12.07	84.60	2.34	0.99					9.91	87.23	1.98	0.88
494						11.97	84.67	2.33	1.03								
496						11.74	85.01	2.29	0.97								
297	49	15.73	80.29	2.91	1.07	15.24	81.00	2.30	0.96	14.98	81.05	3.01	0.96				
299						15.42	80.62	2.93	1.03					14.07	82.20	2.84	0.89
497						14.86	81.55	2.62	0.97								
499						15.48	80.60	2.80	1.12								
298	50	13.89	81.06	3.90	1.15	12.79	82.71	3.51	0.99	12.25	83.38	3.40	0.97				
300						13.01	82.40	3.74	0.85					11.80	84.04	3.32	0.84
498						13.28	82.17	3.66	0.89								
500						12.82	82.59	3.70	0.89								
301	51	15.74	80.42	2.94	0.90	14.80	81.62	2.61	0.97	14.94	81.28	2.82	0.96				
303						14.94	81.57	2.63	0.86					14.99	81.20	2.88	0.93
501						15.33	81.00	2.81	0.86								
503						14.74	81.83	2.38	1.05								
302	52	13.31	84.10	1.85	0.74	12.65	84.76	1.71	0.88	11.97	85.47	1.67	0.89				
304						12.85	84.56	1.71	0.88					11.51	86.02	1.58	0.89
502						12.85	84.54	1.58	1.03								
504						13.00	84.57	1.63	0.80								
305	53	15.55	81.61	2.04	0.80	15.34	81.88	2.03	0.75	13.93	83.45	1.71	0.91				
307						15.28	82.02	1.74	0.96					14.33	83.02	1.72	0.93
505						15.45	81.63	1.86	1.06								
507						15.25	81.85	1.92	0.98								
306	54	13.22	84.44	1.79	0.55	12.77	84.99	1.60	0.64	11.86	85.90	1.47	0.77				
308						13.35	84.24	1.56	0.85					11.86	85.79	1.52	0.83
506						13.12	84.45	1.56	0.87								
508						13.82	83.85	1.58	0.75								

TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage			
		Percent				Percent				Percent			
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
309	55	14.59	82.83	1.77	0.81	13.91	83.52	1.49	0.08	13.39	84.20	1.51	0.90
311						14.96	82.44	1.79	0.81	13.14	84.55	1.41	0.86
509						14.15	83.43	1.57	0.85				
511						14.38	83.37	1.61	0.64				
310	56	13.31	84.30	1.68	0.65	13.40	84.34	1.33	0.93	12.15	85.62	1.30	0.87
312						12.60	85.09	1.52	0.79	13.80	83.41	1.75	0.98
510						13.09	84.60	1.46	0.85				
512						12.52	85.32	1.39	0.77				
313	57	15.74	81.05	2.51	0.70	16.31	80.06	2.46	1.17	13.50	83.47	2.15	0.88
315						15.52	81.15	2.25	1.08	14.22	82.58	2.20	1.00
513						15.37	81.34	2.20	1.09				
515						15.14	81.58	2.26	1.02				
314	58	13.01	84.57	1.93	0.49	12.65	84.96	1.80	0.59	11.54	86.01	1.73	0.72
316						12.60	84.91	1.83	0.66	11.76	85.60	1.70	0.88
514						12.58	85.00	1.68	0.74				
516						12.67	84.84	1.81	0.68				
317	59	16.54	79.18	3.50	0.78	15.00	80.88	3.06	1.06	13.23	83.20	2.71	0.81
319						15.43	80.45	3.09	1.03	13.38	83.03	2.75	0.84
517						16.15	79.58	3.24	1.03				
519						16.31	79.52	3.16	1.01				
318	60	13.48	83.70	2.21	0.61	13.01	84.24	1.90	0.79	12.40	84.51	2.11	0.98
320						12.98	84.25	1.99	0.78	12.11	85.19	1.92	0.78
518						13.19	83.95	2.05	0.81				
520						13.29	83.95	2.10	0.66				
321	61	16.06	80.39	2.69	0.86	15.47	80.97	2.46	1.10	14.47	82.22	2.36	0.95
323						15.03	81.61	2.62	0.74	14.09	82.00	2.23	0.88
521						16.44	79.63	2.73	1.20				
523						15.80	80.71	2.68	0.81				
322	62	14.49	82.18	2.68	0.65	13.26	83.61	2.33	0.80	12.39	84.56	2.12	0.93
324						13.74	83.11	2.40	0.75	12.10	85.02	2.05	0.83
522						13.62	83.22	2.47	0.69				
524						14.18	82.66	2.45	0.71				
325	63	15.49	81.38	2.33	0.80	15.07	81.91	2.15	0.87	13.88	83.03	2.14	0.95
327						14.77	82.53	2.06	0.64	12.77	84.57	1.68	0.98
525						15.58	81.27	2.24	0.81				
527						15.11	81.85	2.22	0.82				
326	64	13.39	83.85	2.05	0.71	13.16	84.23	1.73	0.88	11.77	85.62	1.66	0.95
328						13.19	83.99	1.91	0.91	12.00	85.45	1.68	0.87
526						12.96	84.09	1.88	1.07				
528						13.40	83.85	1.93	0.82				
329	65	16.15	80.67	2.27	0.91	15.53	81.14	2.16	1.17	14.94	82.04	2.02	1.00
331						15.48	81.30	2.13	1.09	14.15	82.99	1.80	1.06
529						15.47	81.17	2.08	1.28				
531						15.22	81.30	2.04	1.44				

TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage				
		Percent				Percent				Percent				
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	
330	66	14.14	82.23	2.69	0.94	13.13	83.66	2.35	0.86	11.77	85.22	2.09	0.92	
332						13.08	83.78	2.24	0.90	11.80	85.36	2.04	0.80	
530						13.34	83.56	2.37	0.73					
532						13.09	83.77	2.28	0.86					
333	67	15.15	82.02	1.85	0.98	15.16	82.26	1.65	0.93	13.68	83.84	1.56	0.92	
335						14.70	82.77	1.61	0.92	13.34	84.12	1.56	0.98	
533						15.35	81.86	1.64	1.15					
535						15.02	82.35	1.53	1.10					
334	68	12.94	84.42	1.88	0.76	13.35	84.16	1.87	0.62	11.58	86.14	1.43	0.85	
336						13.15	84.18	1.68	0.99	11.06	86.78	1.41	0.75	
534						12.57	84.64	1.76	1.03					
536						12.60	84.94	1.52	0.94					
337	69	15.85	81.02	2.19	0.94	15.88	80.63	2.25	1.24	13.40	84.00	1.64	0.96	
339						15.33	81.38	2.00	1.29	14.10	83.18	1.77	0.95	
537						15.33	81.03	2.09	1.55					
539						14.97	81.74	2.15	1.14					
338	70	13.59	83.59	1.98	0.84	12.90	84.43	1.82	0.83	11.68	85.97	1.57	0.78	
340						12.75	84.65	1.74	0.86	11.68	85.94	1.59	0.79	
538						12.91	84.49	1.84	0.76					
540						12.92	84.50	1.80	0.78					
341	71	14.94	82.22	1.99	0.85	14.51	82.74	1.63	1.12	13.17	84.39	1.55	0.89	
343						15.09	81.81	1.96	1.14	12.51	85.17	1.46	0.86	
541						14.60	82.40	1.80	1.20					
543						14.30	82.96	1.65	1.09					
342	72	13.21	84.07	1.91	0.81	13.10	84.21	1.81	0.88	11.30	86.27	1.51	0.82	
344						13.06	84.27	1.82	0.85	11.59	85.97	1.56	0.88	
542						12.87	84.46	1.78	0.89					
544						12.75	84.69	1.72	0.84					
345	73	14.52	82.67	1.97	0.84	14.67	82.37	1.82	1.14	13.03	84.42	1.77	0.78	
347						15.51	81.20	2.18	1.11	13.56	83.84	1.75	0.85	
545						15.09	81.55	2.00	1.36					
547						14.77	82.07	2.00	1.16					
346	74	12.80	84.42	1.78	1.00	12.80	84.69	1.62	0.89	11.37	86.37	1.52	0.74	
348						12.69	84.81	1.71	0.79	11.33	86.47	1.48	0.72	
546						13.17	84.21	1.83	0.79					
548						11.56	85.78	1.65	1.01					
349	75	14.21	81.89	3.12	0.78	14.15	82.01	2.77	1.07	12.10	84.75	2.33	0.82	
351						14.27	81.65	3.06	1.02	13.35	82.82	2.96	0.87	
549						14.52	81.57	3.02	0.89					
551						14.13	82.14	2.81	0.92					
350	76	13.08	84.58	1.55	0.79	12.62	85.29	1.40	0.69	11.65	86.19	1.32	0.84	
352						12.77	85.04	1.44	0.75	11.41	86.43	1.24	0.92	
550						12.80	84.94	1.49	0.77					
552						12.83	84.95	1.39	0.83					



TABLE 13—Continued

Tub No.	Ch'n No.	Samples taken from churn				Four tubs 24 hours later				After 6 to 7 months in storage			
		Percent				Percent				Percent			
		Water	Fat	Salt	Casein	Water	Fat	Salt	Casein	Water	Fat	Salt	Casein
353	77	15.15	82.26	1.69	0.90	15.22	82.15	1.54	1.09	12.02	83.64	1.47	0.87
355						14.83	82.67	1.52	0.98	13.36	84.40	1.32	0.92
553						15.30	82.38	1.46	0.86				
555						15.25	81.87	1.80	1.08				
354	78	13.59	83.85	1.77	0.79	13.78	83.61	1.64	0.97	12.16	85.71	1.32	0.81
356						13.96	83.26	1.57	1.21	11.88	85.90	1.41	0.81
554						13.76	83.57	1.79	0.88				
556						13.56	83.84	1.66	0.94				
357	79	14.14	83.46	1.63	0.77	14.46	83.12	1.50	0.92	12.81	85.00	1.31	0.88
359						14.69	82.52	1.63	1.16	12.71	85.04	1.26	0.99
557						14.04	83.34	1.46	1.16				
559						14.19	83.08	1.43	1.30				
358	80	13.19	84.64	1.41	0.76	13.70	84.11	1.36	0.83	12.15	85.81	1.23	0.81
360						13.38	84.38	1.31	0.93	12.07	85.88	1.22	0.83
558						13.35	84.45	1.20	0.91				
560						13.19	84.15	1.39	0.87				
Av.		14.32	82.03	2.25	0.90	13.71	83.34	20.80	0.88	12.62	84.55	1.98	0.85

GENERAL SUMMARY OF TABLE 13

Number of samples analyzed	Samples taken from			Difference between		
	Churn	Tub 24 hours later	Tub after storage	Churn and tub	Tub before and after storage	
High moisture and low fat butter						
40	Percent water	15.31				
160				14.69	0.62	
80				13.64		1.05
40	Percent fat	81.25				
160				82.02	0.77	
80				83.24		1.22
40	Percent salt	2.49				
160				2.31	0.04	
80				2.23		0.08
40	Percent casein	0.95				
160				0.95	0.00	
80				0.89		0.07
Low moisture and high fat butter						
40	Percent water	13.32				
160				12.74	0.58	
80				11.60		1.14
40	Percent fat	83.81				
160				84.66	0.85	
80				85.86		1.20
40	Percent salt	2.02				
160				1.84	0.18	
80				1.73		0.11
40	Percent casein	0.84				
160				0.81	0.03	
80				0.81		0.00

A preliminary study of the composition of various samples of butter taken from the same churning or tubs of butter, gave a large amount of data which is verified in the above Table.

While analyses of samples taken to represent the same butter will not give like results, yet from previously accumulated data we know that the analysis of one sample properly taken will give the approximate composition of the butter in question. From Table 8, Influence of Pasteurization upon Composition of 1907 Butter, the average results show that the water content of all the samples taken from the 56 churnings is approximately one percent higher than the average of all the samples taken from the tubs before storage. The same degree of difference is found between samples of the butter taken from these same tubs after storage. Does this difference indicate that the variation is due to the method of sampling; to actual loss of water in packing; or a loss of water incident to storage? An average of the tub analyses furnishes a basis for calculating the amount of fat recovered in the butter. This was done for the 56 churnings in 1907. The final average for each churning day was 452.5 pounds of butter fat and of this amount 447.1 pounds were recovered, based on the average of the chemical analyses. The only loss of butter fat was in the butter-milk.

Since butter fat in the cream as determined by the Babcock Test, corresponds so closely to butter fat recovered in the butter, as determined by chemical analysis of tub sample, it is reasonable to conclude that the tub sample quite accurately represents the average composition of the butter.

TABLE 14. BUTTER FAT RECEIVED, CHURNED AND RECOVERED IN THE BUTTER IN 56 CONSECUTIVE CHURNINGS

Date 1907	Lb. cream received	Percent fat	Butter fat	Pounds in each churning			Lb. butter made	Tub No.	Percent fat in each tub,	Average per cent fat in 2 tubs	Lb. butter fat recovered	
				Cream	Percent fat	Butter fat						
June 3	818	35.5	290.39	500	30.00	150.0	178.0	1	84.59		150.57	
				475	30.00	142.5	166.0	2	85.26		141.53	
						292.5					292.10	
June 4	1104	33.0	364.32	620	29.00	179.80	210.0	3	85.17		178.85	
				629	29.00	182.41	215.0	4	85.01		182.77	
						362.21					361.62	
June 7, 8	1239	31.5	390.29	385	26.00	100.10	117.0	7	84.98		85.09	
								8	85.07		99.479	
				391	26.00	101.66	119.0	11	85.04		85.24	101.435
								12	85.44			
				350	27.00	94.50	113.0	5	84.63		84.36	95.326
								6	84.09			
				350	27.00	94.50	113.0	9	83.75	84.09	95.021	
								10	84.43			
			390.29			390.76					391.26	
June 11, 12	1586	32.0	507.52	464	27.00	125.28	147.5	15	84.30		83.77	
								16	83.24		123.56	
				506	27.00	136.62	154.0	19	84.85		85.16	131.146
								20	85.47			
				464	27.00	125.28	148.0	13	82.73		82.435	122.003
								14	82.14			
				464	27.00	125.28	141.0	17	85.09		84.695	119.419
								18	84.30			
			507.52			512.46				496.128		
June 14, 15	1566	31.5	493.29	461	26.00	119.86	139.0	23	83.39		83.235	
								24	83.08		115.696	
				513	26.00	133.38	150.0	27	84.38		84.63	126.945
								28	84.88			
				461	26.00	119.86	140.0	21	83.67		83.54	116.956
								22	83.41			
				451	26.00	117.26	138.0	25	82.27		82.205	113.442
				26	82.14							
			493.29			490.36				473.039		
June 18, 19	2210	32.5	718.25	620	28.00	173.60	211.0	31	84.35		84.445	
								32	84.54		178.178	
				674	28.00	188.72	226.0	35	84.16		83.885	189.58
								36	83.61			
				620	28.00	173.60	209.0	29	84.15		84.11	175.789
								30	84.07			
				648	28.00	181.44	224.0	33	81.96		82.07	183.836
								34	82.18			
			718.25			717.36				727.383		

TABLE 14—Continued

Date 1907	Lb. cream re-ceived	Per-cent fat	But-ter fat	Pounds in each churning			Lb But-ter made	Tub No.	Per-cent fat in each tub	Aver-age per-cent fat in 2 tubs	Lb butter fat re-covered	
				Cream	Per-cent fat	But-ter fat						
June 21, 22	1688	34.0	573.92	516	26.0	134.16	156.0	39	83.47	83.83	130.774	
				499	26.0	129.74	153.0	40	84.19			
				516	26.5	136.74	162.0	43	84.63			
				503	26.5	133.295	159.0	44	84.90			
								37	82.79			
								38	83.70	83.245	134.856	
								41	83.19	83.465	132.709	
								42	83.74			
			573.92			533.935					528.029	
June 24	651	29.0	188.79	499	20.0	99.80	121.0	47	83.14	83.08	100.526	
				452	20.0	99.40	104.0	48	83.02			
								45	83.95			
			188.79			190.20					187.891	
June 25, 26	1503	35.0	526.05	431	29.0	124.99	146.5	51	84.32	84.06	123.147	
				521	29.0	151.09	179.0	52	83.80			
				431	29.0	124.99	149.0	55	84.65			
				430	29.0	124.70	147.0	56	84.64			
								49	83.31			
								50	83.18	83.245	124.035	
								53	84.23	84.44	124.126	
								54	84.65			
			526.05			525.77					522.822	
June 28, 29	1440	034.	489.60	430	28.0	120.40	144	59	83.77	83.79	120.657	
				479	28.0	134.12	162	60	83.81			
				430	28.0	120.40	144	63	83.81			
				425	28.0	119.00	144	64	84.39			
								57	82.50			
								58	82.29	82.395	118.648	
								61	82.34	82.545	118.864	
								62	82.75			
			489.60			493.92					494.41	
July 1	438	37.0	162.06	370	22.0	81.40	92	67	83.58	83.985	77.266	
				364	22.0	80.08	92	68	84.39			
								65	79.95			
			162.06			161.48					79.755	73.374
								66	79.56			
July 2	1436	34.5	495.42	428	29.0	124.12	148	71	83.78	83.735	123.927	
				428	29.0	124.12	149	72	83.69			
				428	29.0	124.12	149	75	83.13			
				436	29.0	126.440	151	76	83.78			
								69	81.88			
								70	81.84			
								73	83.66	83.550	126.160	
								74	83.44			
			495.42			498.80					496.405	

TABLE 14—Continued

Date 1907	Lb. cream received	Per cent fat	But-ter fat	Pounds in each churning			Lb. but-ter made	Tub No.	Per cent fat in each tub	Aver- age per- cent fat in 2 tubs	Lb. butter fat re- covered			
				Cream	Per cent fat	But-ter fat								
July 5	1480	33.0	488.40	436	27.5	119.90	141	79	82.97	83.12	117.199			
				444	27.5	122.10	145	80	83.27		83	84.28	84.30	122.230
				436	27.5	119.90	139	84	84.32		77	80.86	80.77	112.270
				454	27.5	124.85	151	78	80.68		81	81.47	81.485	123.042
									82		81.50			
			488.40			486.75					474.741			
July 9, 10	1940	34.0	659.60	600	27.5	165.50	195	87	81.88	82.38	160.641			
				606	27.5	166.65	196	88	82.88		91	83.85	84.105	164.845
				600	27.5	165.50	197	92	84.36		85	83.80	83.585	164.662
				600	27.5	165.50	198	86	83.37		89	82.30	82.51	163.369
									90		82.72			
			659.60			663.15					653.517			
July 12, 13	1798	29.0	521.42	515	26.0	133.90	156	95	84.31	84.26	131.445			
				512	26.0	133.12	159	96	84.21		99	84.02	83.93	133.448
				515	26.0	133.90	162	100	83.84		93	81.64	81.715	132.378
				496	26.0	128.96	155	94	81.79		97	85.02	84.95	131.672
									98		84.88			
			521.42			529.88					528.943			
July 15, 16	1069	36.5	390.185	418	24.0	100.32	118.5	103	83.12	83.170	98.556			
				405	24.0	97.20	112.0	104	83.22		107	84.03	83.875	93.940
				418	23.5	98.23	116.5	108	83.72		101	83.70	83.775	97.597
				408	23.5	95.88	114.0	102	83.85		105	82.66	82.81	94.403
									106		82.96			
			390.185			391.63					384.496			
Total amount handled			7259.50			7241.16	8565.0				7154.43			
Aver. per day			453.71			452.57	535.3				447.15			

### COMPARISON OF BUTTER FAT CHURNED AND RECOVERED IN THE BUTTER

The results obtained from these comparisons gave such interesting data in the 1907 experiments that it seemed best to collect additional data of a similar nature. The 1908 experiment offered an excellent opportunity for this work since it was conducted on a much larger scale, thus reducing the percent of mechanical error and giving more uniform results.

To obtain an accurate determination of the butter fat handled in each of the twenty comparisons, each delivery of milk and cream was tested, involving a fat determination of 1494 individual samples. The cream thus obtained for each churning day was placed in two ripeners a sample from which was tested in triplicate, from each vat before and after the starter was added. The cream in the ripeners was churned in four churnings from which sixteen representative tubs were packed.

Samples were taken for analysis from the churn and by trier from the tubs twenty-four hours later. The percent of fat found in these samples was in turn compared with the Babcock determination of fat delivered on that respective day.

As an illustration, May 6, the amount of butter fat churned according to each patron's test, was 819 pounds; test of cream in the two ripeners before starter was added gave 809.4 pounds and the test after starter was added gave 807.8 pounds. All of this cream was churned in churnings Nos. 1 to 4. The churns contained 297, 192, 297 and 195 pounds of butter respectively, or a total of 981 pounds. Referring to Table 13, it can be seen that the sample from churn 1 contained 80.81 percent of fat, and the average percent of fat in the four tubs of butter was 83.24. The same method of determination was used in the other three churnings. The total pounds of butter fat recovered for the day was, according to samples taken from churns, 809.06 and from the tubs 826.35. The same system of checking was followed for each succeeding day.

TABLE 15. BUTTER FAT CHURNED AND RECOVERED IN THE BUTTER IN 80 CONSECUTIVE CHURNINGS

Date 1908	Butter fat churned according to test:			Ch'n No.	Pounds butter made	Butter fat recovered in butter according to samples taken from			
	Each patron's delivery	Before starter was added	After starter was added			Churn		Four tubs	
						Percent fat in butter	Pounds fat in butter	Percent fat in butter	Pounds fat in butter
May 6	819	402.6	243.0	1	297	80.81	240.00	83.24	247.22
		406.8	159.0	2	192	83.17	159.68	84.33	161.91
			243.0	3	297	82.66	245.50	84.29	250.34
			162.8	4	195	84.04	163.88	85.58	166.88
	819	809.4	807.8		981	82.52	809.06	84.23	826.35
May 9	962	466.6	291.5	5	348	81.03	281.98	82.58	287.38
		469.6	177.5	6	214	83.66	179.03	84.73	181.32
			297.0	7	354	82.12	290.70	83.02	293.89
			176.8	8	210	82.62	173.50	84.69	177.85
	962	936.2	942.8		1126	82.17	925.21	83.52	940.44
May 13	953	482.0	319.0	9	382	80.51	307.54	82.13	313.73
		474.8	167.6	10	197	84.15	165.77	85.01	167.47
			313.5	11	382	80.42	307.20	81.16	310.03
			165.3	12	199.5	82.24	164.07	83.82	167.22
	953	956.8	965.4		1160.5	81.39	944.58	82.58	958.45
May 15	894.5	446.0	297.0	13	360	80.06	288.21	81.43	293.15
		444.5	151.5	14	178	83.82	149.20	85.26	151.76
			297.0	15	356.5	80.33	286.37	82.12	292.75
			150.0	16	178	83.61	148.82	85.02	151.33
	894.5	890.5	895.5		1072.5	81.36	872.60	82.88	888.99
May 19	945.2	477.8	308	17	376	80.42	302.38	81.93	308.05
		472.8	167.4	18	193	84.60	163.28	85.85	165.69
			308	19	375.5	80.63	302.76	82.23	308.88
			664.4	20	190	84.02	159.63	85.33	162.12
	945.2	950.6	947.7		1134.5	81.82	928.05	83.26	944.63
May 22	957.5	953.7	313.5	21	386	81.15	313.24	82.84	319.76
			161.3	22	197.5	84.46	166.80	85.72	169.29
			313.5	23	390	92.12	320.26	83.50	325.65
			169.8	24	205	84.22	172.65	85.50	175.27
	957.5	953.7	958.1		1178.5	82.56	972.95	84.00	989.95
May 26	1045.5	1059.34	346	25	424	81.25	344.50	81.47	345.43
			185.5	26	223	84.25	187.88	85.00	189.55
			346.5	27	420	80.75	339.15	82.91	348.22
			180.8	28	215	82.91	178.25	84.01	180.62
	1045.5	1059.34	1059.3		1282	81.88	1049.78	82.99	1063.82

TABLE 15—Continued

Date 1908	Butter fat churned according to test:			Ch'n No.	Pounds butter made	Butter fat recovered in butter according to samples taken from			
	Each patron's delivery	Before starter was added	After starter was added			Churn		Four tubs	
						Percent fat in butter	Pounds fat in butter	Percent fat in butter	Pounds fat in butter
May 29	879.7	892.49	297.0	29	358	80.68	288.83	81.98	293.49
			153.9	30	178	84.65	150.67	84.98	151.25
			297.0	31	358	82.52	295.42	84.16	294.13
			143.9	32	167	84.34	140.84	84.67	141.40
							1061	82.54	875.76
June 2	1056	1031.68	352	33	432.5	81.38	351.97	81.59	352.88
			164.8	34	196.0	85.52	167.62	85.68	167.93
			352	35	426.0	82.31	350.64	82.80	352.73
			162.88	36	192.5	84.18	162.04	84.92	163.47
							1247	82.78	1032.27
June 5	1062.7	1063.04	352	37	433	80.06	346.66	81.07	351.03
			176.32	38	210.5	84.18	177.20	85.13	179.20
			352	39	421	81.98	345.13	83.40	351.11
			182.72	40	214	83.25	178.15	84.83	181.54
							1278.5	81.90	1047.14
May 9	1161.6	1145.62	357.5	41	453	79.59	360.54	80.40	364.21
			214.17	42	255.5	84.57	216.07	85.34	218.04
			357.50	43	438	81.60	357.40	81.72	357.93
			216.45	44	265.5	83.58	221.90	84.19	223.52
							1412	81.86	1155.91
May 12	1128.58	1088.64	352	45	428	80.89	346.21	81.88	350.45
			198.72	46	237	83.11	196.97	84.66	200.45
			352	47	432.5	81.60	352.92	82.29	355.90
			185.6	48	221.5	83.13	184.13	84.72	187.65
							1319	81.9	1080.23
June 16	915.4	908.82	302.5	49	375	80.29	301.08	80.94	303.52
			153.17	50	190	81.06	154.01	82.47	156.69
			302.5	51	371	80.42	298.35	81.51	302.40
			148.22	52	173.5	84.10	145.91	84.61	146.80
							1109.5	81.06	899.35
June 18	696.1	692.54	220.5	53	265	81.61	216.26	81.85	216.90
			123.23	54	145	84.44	122.43	84.38	122.35
			220.5	55	266	82.83	220.32	83.19	221.28
			121.27	56	143	84.36	120.63	84.84	121.32
							819	82.98	679.64



TABLE 15—Continued

Date 1908	Butter fat churned according to test:			Ch'n No.	Pounds butter made	Butter fat recovered in butter according to samples taken from.			
	Each patron's delivery	Before starter was added	After starter was added			Churn		Four tubs	
						Percent fat in butter	Pounds fat in butter	Percent fat in butter	Pounds fat in butter
June 19	909.2	900.93	291.50	57	351	81.05	284.48	81.03	284.41
			163.24	58	191	84.57	161.52	84.93	162.21
			291.50	59	357	79.18	282.67	80.11	285.99
			152.11	60	179	83.70	149.82	84.09	150.52
	909.2	900.93	898.05		1078	81.49	878.49	81.92	883.13
June 23	901.6	900.24	291.5	61	355	80.39	285.38	80.73	286.59
			163.24	62	195	82.18	160.25	83.15	162.14
			291.5	63	341	81.38	277.50	81.89	279.24
			150.52	64	178	83.85	149.25	84.04	149.59
	901.6	900.24	896.70		1069	81.59	872.38	82.09	877.56
June 25	688.3	670.72	204	65	254.5	80.67	205.30	81.23	206.73
			147.39	66	175.5	82.23	144.31	83.69	146.87
			175	67	224	82.02	183.72	82.31	184.37
			133.5	68	159	84.42	134.44	84.48	134.32
	688.3	670.72	659.89		813	82.17	667.55	82.69	672.29
June 26	763.26	751.50	245	69	294	81.02	238.19	81.19	238.70
			132.54	70	157	83.59	131.23	84.52	132.69
			245	71	289	82.22	237.60	82.48	238.36
			131.32	72	155	84.07	130.3	83.31	130.83
	763.26	751.50	753.80		895	82.39	737.3	82.74	740.58
June 30		662.16	206.25	73	244	82.67	201.71	81.79	199.57
			123.75	74	144	84.42	121.56	84.87	122.21
			206.25	75	246	81.	201.45	81.84	201.32
			123.75	76	144	84.58	121.79	85.06	122.48
		662.16	660.00		778	83.10	646.51	82.98	645.58
June 30		598.81	168.0	77	199	82.26	163.69	82.27	163.72
			128.4	78	156	83.85	130.80	85.57	130.37
			171.5	79	202	83.46	168.59	83.02	167.70
			128.13	80	152	84.64	128.65	84.27	128.09
	1256.4	598.81	596.03		709	83.46	591.73	83.20	589.88
Gen av each day ...	899.79	893.30	892.71		1076.15	82.90	883.43	82.94	892.57

The summary of Table 15 shows a remarkable coincidence between butter fat delivered, butter fat churned, and butter fat recovered in the butter. The average amount of butter fat received each day was, according to the patron's test, 899.79 pounds; test before starter was added 893.2 pounds and test after starter was added 892.71 pounds. The average butter fat recovered was, according to churn samples 883.43 and tub sample 892.57 pounds. The data are so arranged that each day's comparison is complete in itself except that on June 30, the 1256.4 pounds of butter fat were divided into two comparisons. The total butter made in this experiment was 21,523 pounds. An average for each day of 1076.15 pounds. The average percent butter fat in churn and tub samples were 82.09 and 82.94 respectively. Difference 0.83 percent.

TABLE 16. OVERRUN OBTAINED IN EIGHTY CONSECUTIVE CHURNINGS

Churn No.	According to			Churn No.	According to		
	Butter fat churned	Percent of fat in sample taken from:			Butter fat churned	Percent of fat in sample taken from:	
		Churn	Four tubs			Churn	Four tubs
1	22.2	23.7	20.1	41	26.7	25.6	24.3
2	20.7	20.2	18.6	42	19.3	18.2	17.2
3	22.2	21.0	18.6	43	22.5	22.5	22.4
4	20.4	19.0	16.8	44	22.6	19.6	18.8
5	19.4	23.4	21.1	45	21.5	23.6	22.1
6	20.5	19.5	18.0	46	19.2	20.3	18.1
7	19.2	21.8	20.5	47	22.8	22.5	21.5
8	18.7	21.0	18.0	48	19.3	20.3	18.0
9	19.7	24.2	21.7	49	24.0	24.5	23.5
10	17.5	18.8	17.6	50	24.0	23.3	21.2
11	21.8	24.3	23.2	51	22.6	24.3	22.6
12	20.6	21.6	19.3	52	17.0	18.9	18.2
13	21.2	24.9	22.8	53	20.1	22.5	22.2
14	17.5	19.3	17.3	54	17.7	18.4	18.5
15	20.0	24.5	21.8	55	20.6	20.7	20.0
16	18.6	19.6	17.6	56	17.8	18.5	17.8
17	22.1	24.3	22.0	57	20.4	23.3	23.4
18	15.3	18.2	16.5	58	17.0	18.2	17.7
19	21.9	24.0	21.6	59	22.4	26.2	24.8
20	15.5	19.0	17.2	60	17.7	19.5	18.9
21	23.1	23.2	20.7	61	21.7	24.4	23.8
22	22.4	18.4	16.6	62	19.5	21.6	20.2
23	24.4	21.8	19.7	63	16.9	22.8	22.1
24	20.7	18.7	16.9	64	18.2	19.2	18.9
25	22.3	23.1	22.7	65	24.7	23.9	23.1
26	20.2	18.7	17.6	66	19.1	21.6	19.5
27	21.2	23.8	20.6	67	19.4	21.9	21.5
28	18.9	20.6	19.0	68	19.1	18.5	18.4
29	20.0	23.9	22.0	69	20.0	23.4	23.1
30	15.6	18.1	17.7	70	18.5	19.6	18.3
31	20.5	21.2	21.7	71	18.0	21.6	21.2
32	16.0	18.5	18.1	72	18.0	18.9	18.5
33	22.8	22.8	22.5	73	18.3	20.9	22.2
34	18.9	16.9	16.7	74	16.4	18.4	17.8
35	21.0	21.5	20.7	75	19.3	22.1	22.1
36	18.1	18.7	17.7	76	16.4	18.2	17.5
37	23.0	24.9	23.3	77	18.5	21.5	21.5
38	19.4	18.8	17.5	78	21.5	19.2	19.6
39	19.6	20.9	19.9	79	17.7	19.8	20.5
40	17.1	20.1	17.8	80	18.8	18.1	18.7
Average					20.5	21.8	20.5

The above Table offers a striking comparison of the overrun obtained. The average overrun when based upon butter fat churned was 20.5 percent. The highest overrun for a single churning, No. 41, was 26.7 percent and lowest, in churning 20, which was 15.3 percent. In these same two churnings the composition in the butter packed in the tubs permitted an overrun of 24.3 and 17.2 percent respectively. The Table shows remarkable uniformity between butter fat churned and butter fat recovered. The only mechanical loss considered for each individual churning was the butter fat lost in the buttermilk. If the creamery operators are to use the overrun recorded in the above Table as standard, they must take the following facts into consideration:

1. The loss in handling the milk and cream until it reaches the churn, must be reduced to a minimum.

2. The weight of butter packed must be the same as weight on bill of sale.

3. The butter fat paid for must be approximately the actual amount received.

4. After allowing for the mechanical loss, the overrun should be consistent with the percent of fat actually in the butter. By referring to Table 15, May 26, the butter in the tubs from churning 25 contained 81.47 percent fat and churning 26 from the same vat of cream contained 85.00 percent of fat or a difference in fat content of 3.53 percent.

The greatest factor influencing overrun obtained in creamery operation, is the sampling and testing of the milk and cream received. An error of one-tenth of one percent in testing 4.0 percent milk and one percent in 40 percent cream will alter the overrun 3 percent.

Table 17 is made up from Tables 15 and 16, in order to give a complete daily comparison of the butter fat received and churned, total pounds of butter made, together with the respective overrun.

The final average overrun is the same when based upon butter fat churned and butter fat recovered, according to the percent of fat in samples taken from 320 tubs of butter representing 80 churnings. The overrun calculated from the percent of fat in the samples taken from the 80 churnings is 1.3 percent higher. This difference indicates that, either the reading of the Babcock bottle was high or the churn sample gave a percent of fat lower than is actually in the butter. It is safe to assume that in packing the butter into tubs a small amount of water is forced out which would cause a higher fat content in tub samples. The last column in this Table indicates the percent of overrun based upon butter fat churned after deducting the butter fat lost in the buttermilk. The actual overrun then is one-half of one percent higher than is possible according to butter fat analyses. Considering the large number of samples of cream tested and butter analyzed the results thus obtained are remarkably consistent.



TABLE 18. COMPOSITION OF BUTTER WHEN SAMPLES ARE TAKEN FROM CHURN; FROM FIVE TUBS 24 HOURS LATER AND FROM ONE OF THESE TUBS MELTED

Ch'n No.	Churn sample			Average 5 tubs			Melted tub		
	Percent			Percent			Percent		
	Water	Fat	Salt	Water	Fat	Salt	Water	Fat	Salt
41	16.64	79.59	2.72	15.99	80.56	2.65	16.48	79.95	2.90
42	12.69	84.57	2.05	12.05	85.37	2.01	11.95	85.35	2.07
43	15.37	81.60	2.07	15.45	81.78	2.26	15.62	81.28	2.36
44	13.59	83.58	1.81	13.04	84.34	1.85	12.52	84.29	1.89
45	15.66	80.89	2.82	14.68	82.00	2.53	15.49	80.85	2.82
46	13.50	83.11	2.75	12.26	84.74	2.19	12.70	84.07	2.49
47	15.44	81.60	2.35	14.73	82.36	2.04	15.18	81.78	2.34
48	13.32	83.13	2.86	11.95	84.76	2.31	12.49	84.01	2.57
49	15.73	80.29	2.91	15.70	81.04	2.74	15.42	80.71	3.07
50	13.89	81.06	3.90	13.01	82.45	3.58	13.21	82.26	3.69
51	15.74	80.42	2.94	14.98	81.44	2.60	15.66	80.50	3.00
52	13.31	84.10	1.85	12.83	84.37	1.68	13.21	84.22	1.90
Average of all comparisons									
	14.56	81.99	2.50	13.84	82.95	2.37	14.20	82.44	2.59
Average of the six churnings of high water and low fat butter									
	15.76	80.73	2.63	15.25	81.53	2.46	15.64	80.84	2.39
Average of the six churnings low water and high fat butter									
	13.36	83.60	2.37	12.52	84.34	2.27	12.77	84.03	2.21

TABLE 19. COMPOSITION OF BUTTER WHEN SAMPLES ARE TAKEN BY MEANS OF A TRIER FROM TUB 24 HOURS AFTER IT WAS PACKED; FROM SAME TUB, FROZEN, AFTER SIX TO SEVEN MONTHS IN STORAGE AND FROM SAME TUB MELTED

Tub No	Tub 24 hours after packing			Frozen storage			Melted tub		
	Percent			Percent			Percent		
	Water	Fat	Salt	Water	Fat	Salt	Water	Fat	Salt
281	15.28	81.38	2.36	14.33	82.49	2.45	14.18	82.54	2.58
282	11.86	85.56	1.95	10.57	86.97	1.79	10.88	86.63	1.64
285	15.85	81.10	2.36	14.60	82.38	2.14	14.64	82.52	2.17
286	12.96	84.51	1.84	13.32	83.86	2.02	12.36	85.07	1.75
291	15.10	81.52	2.59	14.40	82.20	2.56	14.56	81.99	2.70
290	12.65	84.66	2.26	11.28	85.82	2.13	11.54	85.47	2.28
295	14.47	82.63	1.90	13.65	83.53	1.95	14.32	82.58	2.27
296	13.32	83.13	2.86	9.91	87.23	1.98	10.60	86.36	2.18
299	15.42	80.62	2.93	14.07	82.20	2.84	14.72	81.71	2.88
298	12.79	82.71	3.51	12.25	83.38	3.40	11.95	83.76	3.41
301	14.80	81.62	2.61	14.94	81.28	2.82	14.76	81.26	2.83
302	12.65	84.76	1.71	11.97	85.47	1.67	12.29	85.07	1.74
Average for all comparisons									
	13.93	82.87	2.40	12.94	83.90	2.31	13.07	83.74	2.37
Average of the six churnings of high water and low fat									
	15.10	81.48	2.46	14.33	82.34	2.46	14.53	82.10	2.57
Average of the six churnings of low water and high fat									
	12.70	84.22	2.35	11.55	85.45	2.16	11.00	85.39	2.17

Tables 18 and 19 show why samples of butter taken for analysis do not always agree, even when representing the same churning of butter.

From the 80 churnings recorded in Table 12, one extra tub was packed from each churning numbered 41 to 52. The analyses under churn samples, Table 18, are the same as recorded in Table 13 for these same churnings. The analyses recorded under average five tubs, are the average of the analyses recorded in Table 13 for the four tubs from each churning together with the extra tub that was packed from each of the 12 churnings. This extra 30 pounds was melted by placing the butter in a milk can, tightly covered. The results obtained by analyzing the sample taken from melted butter show actual composition of that quantity of butter. The average water content of the 12 tubs melted butter was in this case 0.36 of one percent higher than that of the average of the trier samples taken from 60 tubs, and 0.36 of one percent lower than the average of the 12 samples taken from the 12 churns.

In Table 19 there is more of a uniformity between trier and melted sample due to frozen condition of butter when the samples were taken. These tubs are the same as recorded in preceding tables and used in the regular experimental work. They belong to churnings 41 to 52. When all the tubs were brought out of the storage room in Chicago they were sampled while the butter was still frozen and the result of analyzing the 160 samples is recorded in Table 13. The 12 tubs to be melted were shipped to Urbana and the samples obtained from the melted tubs in the same manner as for Table 18. The average of the samples taken from the 12 melted tubs was 0.13 of a percent higher than the trier samples. Trier samples taken after storage contained an average of 0.99 of a percent less water than the average of the samples taken from the same tubs before storage. This decrease in water content during storage is nearly the same as the average decrease of the 106 tubs which was 1.09 of one percent.

TABLE 20. EFFECT OF COMPOSITION UPON QUALITY, BASED ON THE SCORES BY FIVE DIFFERENT JUDGES

Pasteurized Butter											
High moisture and low fat							Low moisture and high fat				
Judges	No.	1	2	3	4	5	1	2	3	4	5
Churn No.	Tub No.										
1	201 203	93. 93.	94. 92.	92.75 91.5	93.5 93.	92.5 93.					
2	202 204						93. 93.	93. 92.5	92.25 92.5	93.5 93.5	93. 93.
5	209 211	93. 93.	94. 93.	92. 91.7	93.5 93.5	93. 92.					
6	210 212						92. 93.	93. 93.	91. 92.75	93. 93.	93. 93.
9	217 219	92. 91.	90.5 90.5	92.75 92.5	92. 92.5	90.5 90.5					
10	218 220						91.5 91.5	91.5 90.	92.25 92.5	92. 90.	92.5 90.5
13	225 227	92.5 91.5	91.5 91.	91.5 92.9	92. 92.5	91.5 92.					
14	226 228						93. 92.5	92. 90.5	92.75 92.	92.5 93.	92. 92.
17	233 235	93. 92.5	93. 92.	92. 92.	92. 93.5	92. 93.					
18	234 236						93. 92.	92. 91.	92. 92.75	92. 93.5	92. 90.5
21	241 243	93. 93.	93.5 93.	92.5 92.	93.5 93.5	92. 92.5					
22	242 244						93. 93.	91. 93.5	92. 92.	93. 93.5	92.5 92.5
25	249 251	93.5 93.	92. 93.	91. 93.	93. 92.5	92.5 93.					
26	250 252						93. 93.	93.5 91.5	92. 93.	93.5 93.	92. 92.5
29	257 259	93. 93.	92.5 93.	92.5 92.5	93. 92.	92. 91.5					
30	258 260						93.5 93.	90.5 93.	92.5 92.	93. 93.	90.5 92.
33	265 267	92. 92.5	93. 92.5	91. 90.5	92. 92.	92.5 92.5					
34	266 268						91.5 92.5	91.5 92.	92.25 92.75	92.5 93.	92.5 92.5
37	273 275	93. 92.5	92.5 90.	91.75 91.75	93. 93.	92.5 92.					
38	274 276						93. 93.	93. 92.	92.5 92.5	93.5 92.	92.5 92.5
41	281 283	93. 92.5	92.5 92.5	91.5 91.	92. 93.	93. 92.					
43	282 284						93. 93.	91.5 92.	92. 92.	92. 92.5	92.5 93.

TABLE 20—Continued

High moisture and low fat							Low moisture and high fat				
Judges	No.	1	2	3	4	5	1	2	3	4	5
Churn No.	Tub No.										
45	289	93.	91.	91.	90.	92.5					
	291	93.	90.5	92.5	93.	92.5					
46	290						93.	90.5	92.	93.	92.
	292						93.	91.5	92.	93.	92.5
49	297	93.	91.5	92.	92.	92.5					
	299	92.5	93.	91.5	93.	92.					
50	298						92.5	92.	92.	92.	92.
	300						93.	92.	91.	89.	92.5
53	305	93.5	90.5	93.	86.	93.					
	307	93.	90.5	93.	90.	93.					
54	306						93.	91.5	92.5	92.	93.
	308						93.	92.5	92.5	90.	92.5
57	313	93.	92.	93.	93.	92.5					
	315	93.	92.5	93.	93.	92.5					
58	314						93.5	93.	92.5	93.	92.
	316						93.	92.5	92.25	92.	92.5
61	321	93.	93.	91.75	92.	92.5					
	323	92.5	92.	92.	92.	92.					
62	322						93.	91.5	92.5	93.	92.5
	324						93.	93.	91.	87.	92.5
65	329	91.	88.	90.5	87.	90.5					
	331	91.	86.	91.	87.	90.5					
66	330						91.5	86.	91.	86.	90.
	332						92.	85.5	91.5	86.	90.
69	337	93.	93.	92.7	592.	92.5					
	339	93.5	92.5	92.5	93.	92.					
70	338						93.	93.	92.75	93.	92.5
	340						92.5	93.	91.75	93.	92.5
73	345	93.	93.	92.	93.	93.					
	347	93.	93.	92.5	93.	92.					
74	346						93.	91.5	92.25	92.	93.
	348						93.	91.	92.5	93.	92.
77	353	93.	91.5	92.	92.5	92.5					
	355	93.	89.5	92.	92.5	92.					
78	354						91.	92.5	93.	93.	93.
	356						91.	92.5	92.	92.5	92.
Average		92.7	91.86	91.98	92.11	92.20	92.67	91.71	92.18	92.07	92.2



TABLE 20—Continued

Unpasteurized Butter											
High moisture and low fat							Low moisture and high fat				
Judges No.	1	2	3	4	5		1	2	3	4	5
Churn No.	Tub No.										
3	205	93.	94.	93.	94.	93.5					
	207	93.	93.	91.	93.	93.5					
4	206						93.	93.	92.25	92.	93.
	208						92.5	91.5	92.75	93.	92.5
7	213	93.	90.	91.	93.	92.					
	215	92.5	92.	91.	92.	92.5					
8	214						93.	91.	91.	93.5	92.
	216						92.	93.	92.	93.5	92.
11	221	92.	92.	90.	93.5	92.					
	223	92.	92.5	92.	92.	91.					
12	222						92.5	93.	91.	93.5	93.
	224						92.5	91.5	93.	93.	92.
15	229	93.	93.	91.5	93.	92.					
	231	93.5	90.5	90.5	93.	90.5					
16	230						93.	92.	91.5	93.	92.
	232						92.5	93.5	91.	93.5	92.5
19	237	93.	93.	92.5	93.	92.5					
	239	93.	92.	91.5	92.	92.					
20	238						93.5	93.	92.	93.	92.5
	240						93.	92.	92.5	93.5	92.5
23	245	93.	93.5	92.5	93.	93.5					
	247	93.	94.	93.	94.	93.5					
24	246						92.5	90.	92.	90.	92.5
	248						93.	92.5	92.5	92.	93.
27	253	93.	93.5	92.5	93.	93.					
	255	93.	93.	92.5	92.	93.					
28	254						93.	93.	91.5	93.	92.5
	256						93.	92.5	92.5	93.5	92.
31	261	93.	93.	92.5	90.	92.					
	263	92.5	93.5	91.75	93.	93.					
32	262						93.	93.	91.5	93.	92.
	264						93.	92.	92.	90.	92.
35	269	92.	93.	91.	88.	92.					
	271	92.	93.	92.25	93.	92.5					
36	270						93.	92.	92.75	92.	92.
	272						93.	93.	91.75	93.	92.5
39	277	92.5	91.5	92.	93.5	92.5					
	279	93.	93.	91.	92.	93.					
40	278						93.	93.5	92.75	93.	93.
	280						93.	93.	92.75	93.	93.
43	285	92.5	93.	91.5	87.	92.					
	287	92.5	92.	92.	92.	92.5					
44	286						93.	93.	92.25	93.	92.5
	288						93.	92.5	91.75	93.	92.5

TABLE 20—Continued

Pasteurized Butter											
High moisture and low fat							Low moisture and high fat				
Judges	No.	1	2	3	4	5	1	2	3	4	5
Churn No.	Tub No.										
47	293	93.	93.5	93.	93.5	93.					
	295	92.5	93.	92.5	93.	92.					
48	294						92.	93.	92.5	93.	91.5
	296						93.	92.	91.5	93.	92.5
51	301	92.	92.5	93.	89.	92.					
	303	92.5	93.	91.75	87.	92.5					
52	302						93.	93.	91.5	92.	92.5
	304						93.	92.	91.5	93.	92.5
55	309	93.	92.	92.5	93.	93.					
	311	93.	93.	91.	92.5	93.					
56	310						93.	92.5	92.5	92.	92.5
	312						93.	92.	92.	93.	93.
59	317	94.	93.	92.25	92.5	92.5					
	319	94.	93.	92.5	90.	92.5					
60	318						93.5	93.	92.5	93.	92.5
	320						93.5	92.5	92.	92.	93.
63	325	93.	93.	92.	92.	92.5					
	317	93.	93.	92.75	93.	93.					
64	326						93.5	93.	91.75	92.	92.5
	328						93.	92.5	91.5	87.	93.
67	333	91.	92.	90.5	87.	90.5					
	335	90.5	91.5	90.5	86.	90.					
68	334						90.5	90.	90.	86.	90.
	336						92.	91.5	91.	89.	90.5
* 71	341	93.5	91.	91.5	93.	92.5					
	343	93.	93.	92.75	93.	93.					
72	342						92.	92.	91.5	92.5	92.5
	344						93.	92.	90.5	92.	93.
75	349	93.	93.5	92.5	92.	93.					
	351	93.	93.	92.	93	92.5					
76	350						93.	93.	90.5	93.	92.
	352						93.	93.	92.5	93.5	92.5
79	357	92.5	92.5	92.5	92.5	92.5					
	359	93.5	93.	92.5	87.	92.5					
80	358						93.	93.	93.	92.	92.
	360						93.	93.	92.5	92.	92.
Average		92.75	92.71	91.91	91.7	92.4	92.78	92.41	91.88	92.25	92.34

TABLE 21. EFFECT OF COMPOSITION ON QUALITY OF BUTTER FOR IMMEDIATE CONSUMPTION, BASED UPON AVERAGE OF ALL SCORES FOR EACH DAY'S MAKE, AS RECORDED IN TABLE 20

Pasteurized				Unpasteurized			
Churn No.	High water	Churn No.	Low water	Churn No.	High water	Churn No.	Low water
1	92.82	2	92.92	3	93.05	4	92.55
5	92.87	6	92.77	7	91.90	8	92.30
9	91.42	10	91.42	11	91.90	12	92.50
13	91.80	14	92.22	15	92.05	16	92.45
17	92.45	18	92.07	19	92.45	20	92.75
21	92.85	22	92.60	23	92.30	24	92.00
25	92.65	26	92.70	27	92.85	28	92.65
29	92.50	30	92.30	31	92.42	32	92.15
33	92.05	34	92.30	35	91.87	36	92.50
37	92.20	38	92.65	39	92.40	40	93.00
41	92.30	42	92.35	43	91.70	44	92.65
45	91.90	46	92.25	47	92.90	48	92.40
49	92.30	50	91.80	51	91.52	52	92.40
53	91.55	54	92.25	55	92.60	56	92.55
57	92.75	58	92.62	59	92.62	60	92.75
61	92.27	62	91.90	63	92.72	64	91.97
65	89.25	66	88.95	67	89.95	68	90.05
69	92.67	70	92.70	71	92.82	72	92.10
73	92.75	74	92.32	75	92.75	76	92.60
77	92.05	78	92.25	79	92.10	80	92.55
Average .	92.17		92.16		92.29		92.34

TABLE 22. EFFECT OF CONSUMPTION ON QUALITY OF BUTTER IN STORAGE BASED UPON AVERAGE OF EIGHT SCORES BY FOUR JUDGES ON EACH DAY'S MAKE

Pasteurized				Unpasteurized			
Churn No.	High water	Churn No.	Low water	Churn No.	High water	Churn No.	Low water
1	91.81	2	92.31	3	91.00	4	91.75
5	92.06	6	91.68	7	91.00	8	90.50
9	90.00	10	91.18	11	90.50	12	90.68
13	91.37	14	91.00	15	91.12	16	91.25
17	91.75	18	91.37	19	91.37	20	90.81
21	91.32	22	91.75	23	91.31	24	90.00
25	91.06	26	91.40	27	91.37	28	88.81
29	91.65	30	90.93	31	90.62	32	90.50
33	91.28	34	91.62	35	91.06	36	90.50
37	91.81	38	91.50	39	90.68	40	91.37
41	91.25	42	91.00	43	90.50	44	90.31
45	90.37	46	91.37	47	90.68	48	90.43
49	91.62	50	91.31	51	91.06	52	91.06
53	91.32	54	91.87	55	91.50	56	91.56
57	91.50	58	91.12	59	90.12	60	91.56
61	90.87	62	91.37	63	90.87	64	90.87
65	89.82	66	88.50	67	89.62	68	88.12
69	92.00	70	91.62	71	91.31	72	91.00
73	91.43	74	91.31	75	91.43	76	90.93
77	90.87	78	89.43	79	89.06	80	86.93
Average .	91.22		91.18		90.81		90.50

Inasmuch as considerable data were at hand concerning composition and its relation to quality, the above data are presented. The same scores are used in another bulletin.

The number of churnings and tubs are the same as recorded in preceding tables. The 160 tubs of butter were scored July 14, 1908. The first tubs of butter were made May 6, and the last lot July 1. Each judge worked independently and duplicate tubs were not known. Table 21 is a summary of Table 20 based upon average of the ten scores placed upon the two tubs of butter representing the same churning. In Table 13, the butter in every other churn beginning with one has a higher water content than the butter in the succeeding churn. Hence, 40 churnings of butter made from pasteurized and unpasteurized cream of a higher water content are compared with 40 churnings of butter made from corresponding lots of cream, with a lower water content. Table 22 is the same comparison except that the averages for the butter from each churn are based upon the scores by four judges, and placed upon the 160 tubs of butter January 13, 1909, or six months after first scoring.

Average of all scores showed no difference in quality. On a certain day the butter made to contain the higher water content might receive the highest average score, while the opposite would be true on another day.

Reasonable variation in composition does not affect quality.





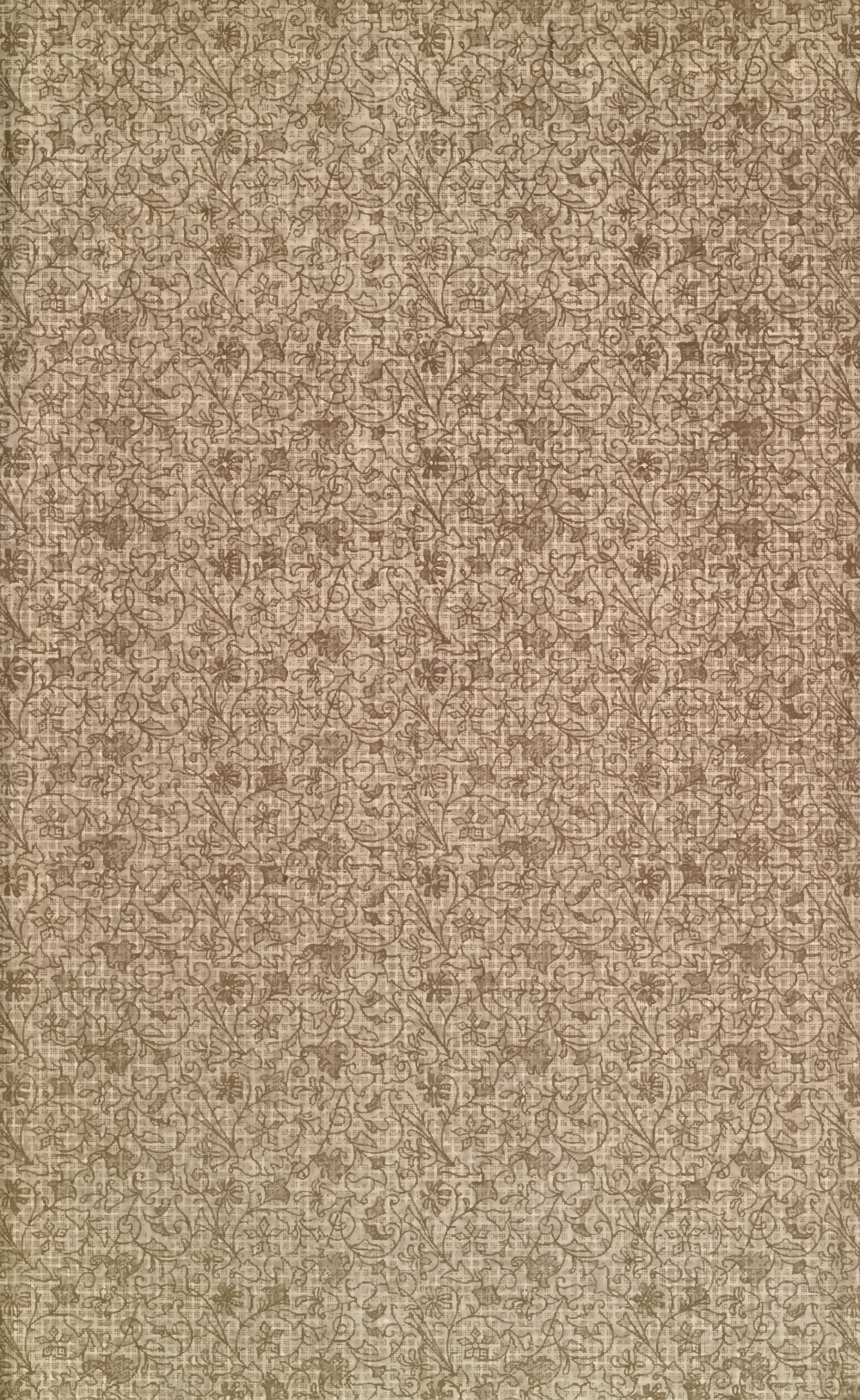












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